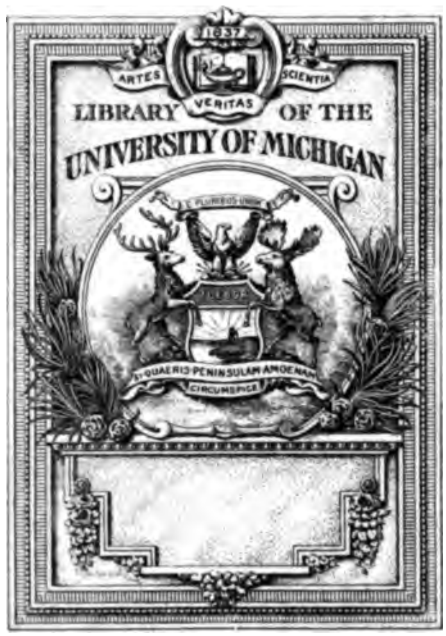
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THE

AMERICAN GEOLOGIST

VOL. XI. JANUARY, 1893. No. 1

THOMAS STERRY HUNT, M. A., D. Sc., LL. D., F. R. S.

By PERSIFOR FRAZER.

The subject of this notice expired of an affection of the heart in the Park Avenue hotel, New York city, February 12th, 1892; a man who made his influence felt in many departments of science, and whose labors in the fields of chemistry, geology, and mineralogy have enriched those sciences; not only directly, but indirectly by drawing the attention of other master minds to many moot points concerning them. On his father's side, his ancestors and their descendants have left enduring remains of their work both in art and letters, one of the earliest of his line who lived in America, William Hunt, having been one of the founders of Concord, Mass. On his mother's side his lineage is enriched by "the gentle, mystic Peter Sterry, and that uncompromising preacher, Thomas Sterry, who wrote the notable tract, 'The Rot Among the Bishops,' in 1667, and that gave to New England Consider and Thomas Sterry, the Mathematicians" (Biographical sketch of T. S. Hunt by James Douglas). Consider Sterry was a civil engineer and the author of text books on arithmetic and algebra in use a hundred years ago. Thomas Sterry Hunt was born in Norwich, Conn., September 5th, 1826. During his early childhood his father moved to Poughkeepsie and died there when the subject of this memoir was but twelve years old; whereupon

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his mother and her family of six children returned to their old home in Norwich. For a while Thomas attended the public school, but soon was called to assist in the support of the family.

He found employment first in a printing office; then in an apothecary's shop; and finally in a book store. Although he remained but six months in each of these situations it is more than probable that his extremely receptive mind was strongly influenced by all of these occupations. He frequently attributed his attention to details in the correction of MS., and his quick and unerring detection of faults in typography, to his experience as a practical printer. His after love of chemistry could not but have been developed if it was not instigated by his surroundings in the second of these situations; and his love of general literature and familiarity with authors doubtless commenced with his opportunity to prowl over a collection of miscellaneous books, absorbing their contents in the interval of his active duties, and laying the foundation of that correct expression and pure style which distinguished to the last his spoken and written thoughts. Some of the elements of Dr. Hunt's genius were a life-long habit of attention, an accurate judgment to select out of the assorted impressions received that which was valuable or new, a phenomenal memory in retaining such concepts, and consistency in adopting them to regulate his conduct or modify his ideas. It is therefore not at all incredible that this exceedingly impressionable mind at its most impressionable age may have assimilated both the tastes and the faculties which directed the course of his after life during the short periods of those diverse occupations. This is rendered the more probable from the fact mentioned by Mr. Douglas, that on leaving these three employments to assume the duties of clerk in a not too busy country store, the future Cantab. Doctor kept a skeleton and certain home-made chemical apparatus under the counter for use in the intervals afforded by his commercial duties. He carried on original research in this rural retreat even while mastering the rudiments of chemistry. He visited the sixth annual meeting of the Association of American Geologists and Naturalists held in the geological lecture room of Yale college from Wednesday, April 30th, to Tuesday, May 6, 1845, and was there elected a member of that body. It is interesting to note that in his nineteenth year, at this, the first meeting he attended of the body

which four years afterwards became the American Association for the Advancement of Science, Dr. C. T. Jackson made a communication "On the copper and silver of Kewenaw Point," and Prof. H. D. Rogers "submitted some remarks on the question of the Taconic rocks," &c., which the speaker believed to be "only the well known lower Appalachian strata disguised by some alteration of mineral type induced by igneous metamorphosis." These two subjects were destined to receive great attention at the new member's hands down to the last days of his life.

At the first meeting of the A. A. A. S., held in Philadelphia, September, 1848, Prof. Hunt read a paper "On Acid Springs and Gypsum Deposits of the Onondaga Salt Group," and at this meeting Profs. W. B. & R. E. Rogers read a paper on "The Comparative Solubility of the Carbonate of Lime and Magnesia," establishing the fact that in water impregnated with CO_2, carbonate of magnesia is more soluble than carbonate of lime." The study related to the formation of dolomites, and contained the germ of an idea splendidly developed by Dr. Hunt in after years in connection with the cause of the difference in per cent. of magnesia of the limestones deposited in the oldest and those in the newer geological seas. One might easily and perhaps profitably trace the origin of many investigations which Dr. Hunt has pursued to brilliant discoveries in the sometimes vague, but to him, suggestive questions and observations at these scientific meetings. He remained in Yale for about a year and a half, until some time in 1846, as the assistant of Prof. B. S. Silliman, Jr., through whose aid and that of Prof. Benj. Silliman, Sr., he obtained the appointment of chemist to the geological survey of Vermont, under the charge of Prof. C. B. Adams.

The year following, on the death of Mr. Dennison Olmstead, Jr., whose place on the Vermont survey he had taken when Mr. Olmstead assumed similar duties for the geological survey of Canada, Mr. Hunt again stepped into the vacated position and moved to Montreal, where began that intimate association with the chief geologist, Sir William Logan, which was to last for twenty-five years, or from 1847 until 1872. During a part of this time he lectured on chemistry (in French) at the University of Laval (1856-'62), and for four years on chemistry and mineralogy at McGill University. Besides these duties and the absorbing work of the geological survey which required not only his research in the labo-

ratory and in the field, but a very considerable amount of the literary supervision of the volumes issued, he wrote an immense number of papers, many of which were contributed to "Silliman's Journal."

His first voyage to Europe was undertaken as a delegate of the Geological Survey of Canada to the International Exposition at Paris, in 1855, where he was selected as one of the jury of award, and during his stay was invested with the decoration of Chevalier of the Legion of Honor. Subsequently he was promoted by the French Government to be an officer of this order.

In 1859 he was elected a Fellow of the Royal Society of London. He was again an official delegate from Canada to the London Exposition of 1862, and afterwards served in the some capacity at Paris in 1867. In 1871 he was elected a member of the National Academy of Science of the United States.

From 1872 to 1878 he resided in Boston and lectured on geology at the Massachusetts Institute of Technology. In 1871 he was elected president of the A. A. A. S. Before this Harvard had recognized his merit and conferred upon him the title of M. A., and the University of Laval that of LL. D. In 1877 he was elected president of the American Institute of Mining Engineers. In 1881 Cambridge University, England, bestowed on him, with more than usual ceremony, the degree of LL. D. He was one of the original members of the Royal Society of Canada and its third president. During the year 1876, of the Centennial Exposition in Philadelphia (where he was also on the jury), he first definitely took measures to insure the calling together of a geological congress of the world, and caused a resolution looking to that end to be passed at the Buffalo meeting of the A. A. A. S.

The reunion of this congress, which occurred in Paris, in 1878, was so far due to his skillful efforts that without his aid it could not have been held at that time, though that there would ultimately have been called together such a congress sooner or later, no one doubts. The first suggestion was made by Dr. Hunt, even if we accept the date at which Prof. Capellini, of Bologna, claims that he made a similar proposition not knowing of the earlier one; but even after the proposal had been accepted by the American Association, and a committee appointed, the enterprise would have been relegated to the dust hole of so many of its magnificent uncompleted plans, but for the tact, skill and perse-

verance of Dr. Hunt, who placed himself in relations with some of the more prominent foreign geologists, wisely adding them at first to the American committee, and afterwards gave indispensable aid to the French committee which organized the first meeting in Paris, in 1878.

At the celebration of the one hundreth anniversary of the discovery of oxygen gas (which was fitly selected as the date of the birth of modern chemistry), held near the grave of Priestley, in Northumberland, Pennsylvania, Dr. Hunt was among the most distinguished guests and vice-presidents, and made, as was usual with him on such occasions, one of the most thoughtful and impressive addresses, entitled "A Century's Progress in Chemical Theory."

It had originally been intended that young Hunt should fit himself for the profession of medicine, but his strong inclination for research in chemistry and geology resulted, as has been shown, in his adopting a career of pure science, interrupted only occasionally by economical reports which only differed from his other work by having the consideration of values added to them.

Among his earlier chemical essays such as "The theory of chemical changes and equivalent volumes," in 1853, it was evident that he was strongly impressed by the brilliant results of Laurent and Gerhardt in the forties and early fifties, and as in so many other cases, this influence is apparent even in his latest chemical works, and is notably in the Northumberland address just alluded to.

It was characteristic of the man that, while fully alive to every new discovery of science, he never forgot the researches of the older savants, and invariably preferred to proceed from their unfinished lines to the newest generalizations, rather than to take a discovery which was a natural consequence of one of these incomplete lines as a new departure. It is through the labors of such men as he that the history of scientific discovery is a continuous narrative and not a mere desultory collocation of dazzling paragraphs. He gleaned the memoirs of the past thinkers, carefully pondering their words and endowing much that was vague and ambiguous with a meaning which bridged over the gap between theirs and the most modern work.

In the "Introduction à l'étude de la Chimie par le systeme unitaire" (Ch. Gerhardt, Paris, 1848, p. 79), the author writes,

"To each metallic or metallous equivalent correspond peculiar properties as we shall see further on. It is as if hydrogen were replaced in these two kinds of combinations by the same metal differently condensed."

Further on he states the law of condensation in the form of $\frac{p}{d} = v$ in which p = atomic weight; d = specific gravity, and v = the atomic volume. Precisely the same equation is used by Dr. Hunt in his essay on "The coëfficient of mineral condensation in Chemistry," &c., where p represents an *aliquot part* of the chemical species, d = the specific gravity, and v = the reciprocal of the coëfficient of condensation. It will be noticed in Dr. Hunt's works that he avoids where possible the employment of the word atom, and uses instead "equivalent weight." He did not believe that the existence of atoms had been demonstrated, nor did he accept the doctrine of interatomic space. He believed matter to be continuous and without interstices. Thus, in the address at Northumberland, he says: "Dalton, as you are aware, linked his discoveries with the old hypothesis of the atomic constitution of matter which is however by no means necessarily connected with the great laws of combination by weight and by number." And again, in his peroration, he says: "The phenomena of chemistry lie on a plane above those of physics and to my apprehension the processes with which the latter science makes us acquainted can afford at best only imperfect analogies when applied to the explanation of chemical phenomena to the elucidation of which they are wholly inadequate. In chemical change the uniting bodies *come to occupy the same space at the same time*, and the impenetrability of matter is seen to be no longer a fact, the volume of the combining masses is confounded, and all the physical and physiological characters which are our guides in the region of physics fail us, gravity alone excepted; the diamond *dissolves* in oxygen gas and the identity of chlorine and of sodium are lost in that of sea salt.

"To say that chemical union is in its essence identification, as Hegel has defined it, seems to me the simplest statement conceivable."

"The type of the chemical process is found in solution, from which it is possible, under changed physical conditions to regenerate the original species. Can our science affirm more than this, and are we not going beyond the limits of a sound philosophy

when we endeavor by hypotheses of hard particles with void spaces, of atoms and molecules, with bonds and links to explain chemical affinities, and when we give a concrete form to our mechanical conceptions of the great laws of definite and multiple proportions to which the chemical process is subordinated? Let us not confound the image with the thing itself, until, in the language of Brodie, in the discussion of this very question, 'we mistake the suggestions of fancy for the reality of nature, and we cease to distinguish between conjecture and fact.' The atomic hypothesis by the aid of which Dalton sought to explain his great generalizations, has done good service in chemistry, as the Newtonian theory of light did in optics, but is already losing its hold on many advanced thinkers in our science."

He says in a previous part of the same address: "The doctrine of types, first enunciated by Dumas, advanced by Laurent and perfected by the labors of others, may be said to be the basis of our present chemical theory. It was the conception of the dual water type which first rendered clear the theory of ethers and anhydrous monobasic acids, and thence the generation of bibasic and tribasic acids, whose derivation from the water type I taught as early as 1848, some years before these views were accepted by Williamson and Gerhardt, whose names are usually associated with this extension of the original doctrine of Dumas."

Relating to his peculiar views in regard to interstellar space and the connection of the matter which he supposed to fill it with an atmosphere, he says (id.):

"If now we admit, as I am disposed to do with Mattieu Williams, that our atmosphere and ocean are not simply terrestrial but cosmical, and are a portion of the medium which in an attenuated form fills the interstellary spaces, these same nebulæ and their resulting worlds may be evolved by a process of chemical condensation from this universal atmosphere to which they would sustain a relation somewhat analogous to that of clouds and rain to the aqueous vapor around us."

Dr. Hunt elaborated this theme in his presidential address before the Amer. Inst. of Mining Engineers on another accasion, his query being, 'whence is all the carbon derived which is found in organic structure and combined in the rocks as carbonates?' and his conclusion that it was drawn from "interstellary space," perhaps indirectly from other planets.

This attitude of Dr. Hunt towards the atomic theory and the concrete notions of atoms and molecules has been assumed in past years by some distinguished chemists and is not yet wholly obsolete. It was due, with little doubt, to the reaction which had set in from the mistaken fear that chemists had been led afield by the brilliant generalizations of Berzelius. The writer has elsewhere considered this panic,* but it is pertinent to mention briefly the facts here.

The great Berzelius had successfully determined the least combining weights of a great number of substances, and had been led to apply to these weights the theory of Dalton, and a theory based upon the electrical results of Sir Humphrey Davy.

He had thus built up his system of atoms, binary, and ternary compounds; each molecule of the latter two being composed of an electro-positive and an electro-negative element or compound. He made the single mistake of supposing that in a supposed electro-positive group no electro-negative element could be found. When he carried this idea into the synthesis of organic compounds, he was met by discoveries (such as Melsens' in 1842, of chloracetic acid) which rendered it impossible for him to maintain this hypothesis. It was not duly considered at the time that the portion of the Berzelian hypothesis which was proven to be inconsistent with the facts was a minor and unessential part of the whole, and that the great and important generalization of this master among masters remained untouched. His ineffectual efforts to bolster up the fallacious part of his system threw doubt on it all, and one by one his strongest supporters abandoned his entire beautiful theory for a species of chemical agnosticism.

Finally, in 1848, Gmelin, in the colossal dictionary of chemistry, (humorously called "a handbook,") abandoned all attempts at graphic description of compounds and went back to the apparent weight of combination of Lavoisier's time. This timorousness of the chemists of that day affected the progress of theory for nearly thirty years, and it was during these years that Dr. Hunt was active in research. [See the History of Chemistry by von Meyer, Leipzig, 1889]. The motive of this abandonment of the ground so gallantly won by Berzelius was doubtless a good one, viz: the desire to avoid the faults of the alchemists, and to confine the

* "The Helps and Hindrances to the Progress of Chemical Theory," Introduction to chemical lecture course at the Franklin Institute, November 10th, 1890.

activity of workers to concrete facts and indisputable conclusions, but it was like a panic in an army, and lost many a great mind like that of Dr. Hunt to the abstract branch of chemical research.

In the period covered by Dr. Hunt's work it was not good form among the masters to consider theoretical chemistry at all, but rather to work sedulously to collect facts. Yet these facts once gained it has resulted that the old fabric of Berzelius has been re-erected. Additional superstructure indeed has been added, but his foundations have been left untouched.

As an illustration of the unconscious repetition by Dr. Hunt of the mental processes of Gerhardt, compare his statement regarding the definition of organic chemistry in "A new basis of chemistry (§ 15) with the following language of Gerhardt: "Comme toutes les matières organiques sans exception aucune, renferment du carbone, on peut dire qu'elle—(la chimie organique)—"est la chimie du carbone." [Ch. Gerhardt Précis de Chimie Organique, Notices préliminaires, Paris, 1844.] The minds of these men worked in similar grooves, and had Dr. Hunt replaced Laurent in collaboration with Gerhardt it is very probable that similar results would have been obtained.

His research in mineralogy and geology was of similar character to that in chemistry. Here again besides the keen observing power of a "Forscher" Dr. Hunt was an attentive student of the literature of his subject, and he seldom, if ever, made the mistake of beginning an old investigation as if he were the first to think of it. On the contrary, it seemed his mission to exhume and revitalize the views of the oldest savants in the subjects that he treated; imparting to their words a meaning which either had not been understood, or the import of which had been overlooked. It is thus that we find him going back to Werner's views in his "crenitic" hypothesis; to Amos Eaton, in his reconstruction of the base of the American column; to Breithaupt, in his classification of mineral species. And whether or not in every case the original views of his subject justified his interpretation of them, the attention which he called to these views threshed out the remaining seed which had not been previously extracted and made more secure the fame of the old masters. The tendency of this treatment also was beneficial in restricting the number of new "schools."

On the other hand it must be acknowledged that Dr. Hunt in

the later period of his life often spent too much of his valuable time in reclamations of precedence in the announcement of generalizations which had been ascribed to others, basing his claim sometimes on printed words of his own which did not unmistakably define the same ideas. There is no question that in these cases he was sincere, and that from his point of view his claims were just, for he commenced his useful career as a scientific writer with more than the usual amount of that caution which is the indispensable quality of a true savant. Still, he was the unquestioned author of so much that was valuable that he might well have spared himself the controversy and annoyance of these struggles, some of which were very unpleasant to him.

He will be remembered chiefly by his valuable additions to our knowledge of the constitution of the crystalline rocks and his theories concerning their genesis and classification. His leading thought for thirty years was that minerals took the place in crystalline rocks of fossils in the clastic rocks as a means of determination of their history, relative age, &c., but he nowhere pretended (as sometimes has been unjustly said of him) that we were yet able to interpret aright all of the phenomena they presented.

He was an enthusiastic admirer of flowers and a skillful botanist and arborist, contributing much to bring to the attention of the public the necessity of caring for our wantonly wasted forests, and interesting himself greatly in the establishment in Canada and the United States of Arbor day.

He was also a keen critic and an omniverous reader of the current French and English literature, being especially fond of poetry. His memory of the thoughts of those poets whom he most admired was extraordinary, and as a rest from the graver labors of a geological investigation he would sometimes repeat pages of graceful lines. While extremely cautious in expressing any opinions on religious subjects he did not conceal from those who enjoyed much of his society that he was an agnostic of his own peculiar kind, neither affirming nor denying any of the dogmas of any church, but finding much to respect in all of them.

Like most men of ability, Dr. Hunt admired women and recognized the need of their refining influence. He was too great a man to be above enjoying "small talk" when he found himself among those who produced no other kind, and if it was surprising

to hear this learned scientist repeating pages of sentimental verse, it was still more so to note that not only could he on occasion excel in the art of colorless polite conversation, but invariably excited the admiration of his hearers by his accurate memory for the thousand trifles which form its staple, and, in fact, actually enjoyed it. Nevertheless, a word was enough to divert him from this light pastime, and he would lose the smiling presence which accompanied his badinage and drop by instinct into a thoughtful and well expressed monologue.

He had a keen sense of the humorous and a loud and contagious laugh which inspired in others as much hilarity as the sally which called it forth. His nature was emotional, but controlled by strong and well balanced reasoning power, so that no serious view of his on any scientific subject was influenced by it. It follows that where this reasoning power was not exercised, as in the ordinary small worries and mishaps of life he exhibited an extreme passion, tenderness, or sensitiveness. This characteristic while it enabled him to enjoy much that was unfelt by a coarser nature, was nevertheless, the cause to him of extreme suffering from causes which would have made no impression on most men.

His weaknesses were not those which could detract from his greatness, nor did they contain anything sordid or hateful, while the salient points which distinguished him above others placed him in that indefinable class of great men whose thoughts have moulded our century. It was an instructive lesson in psychology to stand beside him and observe how smoothly and forcefully his mind worked on subjects of the greatest difficulty, and how beautifully it recorded its work in well chosen sentences cadenced to express the smallest variations of meaning, and so beautifully clear as to render further interpretation unnecessary even for the least intelligent of his hearers.

The conversion of Dr. Hunt from the views of Mather, who in 1843 rejected the theory which assumed the Adirondacks or Macomb mountains to be primary gneiss, as described by Maclure in 1817 and afterwards more fully by Amos Eaton in 1832, and substituted another in which a great part of the crystalline rocks of New York, such as the Highlands, and also those of Canada, were considered altered Silurian deposits, gives a good illustration of his fairness and astuteness. While Murray and his official superior,

Logan, were of the opinion that the Green Mountain range in Canada was altered paleozoic, Hunt was privately convinced of the truth of the conclusions drawn by Macfarlane & Bigsby in 1862-63, and though for several years he could not state his change of view in the official publications of the Canada Geological Survey, he announced it in 1870, and added additional reasons in its support. Dr. Hunt has given a sketch of this episode in the AMERICAN GEOLOGIST. [Geological history of the Quebec group, vol. v, p. 212, 1890.]

This conversion made him an active partisan of the pre-Cambrian party in similar controversies in other countries, and brought him in contact with Dr. Hicks, who in 1867, in collaboration with Harkness, published his reasons for differing from the opinion of De La Beche, Murchison and Ramsay, that the crystalline schists of north and south Wales were altered Cambrian. Hicks finally announced in 1877 that they belonged to two unconformable series of different geological ages, but both older than the oldest Cambrian. In 1878 Dr. Hunt, Prof. Hughes, of Cambridge, Prof. Torell and others, visited the localities in Anglesey and Carnarvonshire, and confirmed Dr. Hick's conclusions. The history of this controversy between the official geologists of the British Geological Survey and Dr. Hicks, and ultimately the complete triumph of the latter, are matters of recent occurrence. Dr. Hunt lent valuable assistance to his Welsh friend besides finding a confirmation of his own conclusions as to the pre-Cambrian character of like American series in this analogous discovery across the sea.

One of the secrets of Dr. Hunt's success was his indefatigable industry. He rarely made notes in the field, but on returning from a long and arduous day's tramp through the mountains retired to his room after the evening meal and wrote down the results of the day's work; thus sparing himself many an erasure of opinions expressed in the morning which further observation in the afternoon served to refute. This labor would often occupy him far into the night, but he never omitted it, and his thus thoughtfully compiled notes often became without change, parts of his permanent works.

He was one of the few great observers who was also a great

generalizer. Many persons who could not fully grasp his ideas spoke disparagingly of the manner in which he would often allude to some geological horizon as occurring from Alabama to Canada, but he had well weighed his words before making such statements, and further investigation but serves to confirm their accuracy.

He could see farther into the plan of construction of the earth's shell than his observations would justify him in asserting, and he chafed at the restrictions which the slow accumulation of facts condemned him to; still he did not abuse that highest of research's weapons, the scientific imagination, but subordinated it in stating conclusions, and only gave it full play in the reconnaissance which precedes research.

By Dr. Hunt's death, science is poorer by one earnest votary, and America is deprived of one brilliant and useful son.

MAN AND THE GLACIAL PERIOD.*

R. D. Salisbury, Chicago, Ill.

This volume does not profess to be a contribution to advanced science, so much as a summary of the work heretofore accomplished in certain lines of scientific activity. In its author's words, it is intended to give "a clear view of the present state of progress in one department of the inquiries concerning man's antiquity," that department being indicated by the title of the book. The standards by which the book is to be judged are therefore not the standards which would be made use of were the book an original contribution.

The general scope of the book may be indicated by the headings of the various chapters. These are as follows: I. Introduction. II, Existing Glaciers. III. Glacial Motion. IV. Signs of Past Glaciation. V. Ancient Glaciers in the Western Hemisphere. VI. Ancient Glaciers in the Eastern Hemisphere. VII. Drainage Systems in the Glacial Period. VIII. Relics of Man in the Glacial Period. IX. The Cause of the Glacial Period. X. The Date of the Glacial Period.

The purpose of the introduction is the definition of some elementary terms used in glaciology. Unfortunately some of the definitions given are incomplete, while others are so far erroneous as to be wholly misleading if one is dependent on them. A glacier is said to be "a mass of ice so situated and of such size as to have motion in itself," (p. 2.) Névé is said to be the "motionless part" of a glacier. To this motionless névé is attributed the function of generating the

*By G. Frederick Wright, International Scientific Series. D. Appleton & Co.

"impulse" which gives the glacier its first movement, (p. 3). The statement concerning the origin of terminal moraines recognizes only superficial material as entering into their constitution, (p. 6). Kettle-holes are ascribed to the melting of ice buried by debris, (p. 7), but on page 68 it is only a "majority" of "kettles," which are thus explained. With the exception of that concerning névé, these definitions are not wrong, but they are incomplete, and are likely to give use to erroneous conceptions.

The chapter on existing glaciers is a convenient summary of known data concerning the distribution of existing glaciers. It could have been desired that fuller references to authorities had been given here and elsewhere. Perhaps the popular character of the book makes their omission pardonable.

The discussion of the signs of past glaciation is concise and to the point and will commend itself to all readers. But we notice that in this connection one line of evidence which is locally crucial, and always significant, viz.: topography, is entirely omitted.

Chapters V, VI and VII are those which will most interest geologists. The chapter on ancient glaciers in the western hemisphere gives a brief account of the glacial period in North America, accompanied by much fuller consideration of details concerning the drift formations of Pennsylvania than is demanded by the purpose of the book. The details add nothing to the portrayal of the subject in hand, and can hardly fail to be confusing to those who are not geologists.

The position of the terminal moraine from the Atlantic coast westward to Ohio is carefully defined. But where the moraine departs from the margin of recognized drift, our author leaves the morainic line and traces out the line which marks the border of drift, without clearly indicating that the one line is not a continuation of the other. The departure of these two lines from each other west of Pennsylvania, taken together with all concomitant phenomena, is most significant for the theme of the book. To the divergence of these two lines we attach much more importance than does Prof. Wright. We should, therefore, have emphasized their separation much more than he does.

Some ideas advanced in this chapter are not likely to command general assent. Concerning drumlins in general it is said (p. 76) that "if time enough had elapsed, the whole accumulation (of the drumlins) would have been leveled by the glacier, and spread over the broader area where the more rapid lines of movement became confluent, and where the differential movement was less marked." This statement would seem to make drumlins the result of a destructive process, interrupted before its completion. This statement is made in connection with a reference of approval to Prof. Davis' view concerning the origin of drumlins, though it is not clear whether or not professor Wright means to attribute this particular notion to Davis. The idea that drumlins are the result of a destructive process interrupted before its completion, finds further expression where the

author says (p. 94) that the drumlins of central New York "are probably remnants of a morainic accumulation which were made during a pause in the first advance of the ice, and were finally sculptured into their present shape by the onward movement of the ice." This view concerning the origin of certain drumlins was suggested (by Hitchcock, we believe) many years since, but we are not aware that it has found general acceptance. The peculiarly elongated character of the New York drumlins, quite unlike the "choppy" form of morainic hills, would seem to make this notion of their origin less applicable to the drumlins of central New York than to those of any other region. Surely the author is not consistent in accepting Davis' idea of drumlin origin, which distinctly makes them constructive forms, and in accepting also this other idea, which as distinctly makes them destructive forms.

On p. 100, the *interlobate* moraines which have been so carefully differentiated from other forms of terminal moraines, are referred to as "a sort of medial moraine." If Prof. Wright's definition of medial moraines on p. 6 be right, and we think it is, these interlobate moraines are not in any sense medial moraines. They are *terminal* to two ice lobes along their line of meeting, and are, *therefore, interlobate* and *not in any sense "medial."*

It seems to us unfortunate, too, that at a stage in the development of glaciology when kames and eskers are coming to be differentiated, that they should be classed together in a book which purports to be up with the times. These two drift forms are no doubt somewhat related, and the one may locally run into the other, but the types, as such, seem reasonably distinct.

We are compelled to dissent from our author's statements (pp. 89, see also pp. 84-85) to the effect that in passing over a region furrowed by valleys, the ice should extend further from its origin on the elevations, than in the valleys. We are not familiar with the facts in Pennsylvania, but in all regions with which we are familiar, the ice went further south in the depressions than on the uplands, and we do not see how any other condition of things could be possible, as a general fact.

To the statement (p. 69) "it should always be borne in mind that they [glacial striæ] represent the work done during the closing stages of the [ice] period," we also take exception. It seems certain that striæ made when the ice first invaded a region might easily become buried by drift, so as to be preserved indefinitely.

It is to be regretted that a volume which has the commendable purpose of setting forth in popular form the results of glaciology to date, should lay so much stress upon the unity of the glacial period. If Prof. Wright believes there was but one glacial epoch during the glacial period, he has a right to his belief, which no one will dispute. But since the aim is to set forth the present condition of opinion, it would have been better to have indicated that the view advocated in the volume is the view of the minority of those competent to form

judgments in the premises. No one who holds the view that there were two or more glacial epochs can complain that our author attempts to meet their arguments, but they could wish that he had given them more appreciative and more adequate consideration. This much at least was due his readers. It does not seem to us that the arguments for more than one ice-epoch are at all met in any single instance. No point is urged against distinct epochs, which the believers in recurrent epochs have not carefully considered, and regarded as insufficient to overbalance the positive evidence on the other side.

If we understand the arguments which have been adduced for more than one glacial epoch, Prof. Wright has altogether ignored one of the strongest of them, unless his third point (p. 118) is a misinterpretation of it. He refers to the "argument for two distinct glacial periods, (we presume he means epochs) drawn from the smaller apparent amount of glacial erosion over the southern part of glaciated area. * * * * " As we understand the erosion argument, the above does not touch it. The argument is this: The older drift sheet (as interpreted by most glacialists who have studied it) *has suffered much more subaerial erosion since it was laid down* than has the newer drift sheet;—many glacialists would say several times as much. This is the only erosion argument we have known to be especially urged in support of two ice-epochs, and this our author does not touch.

Since the idea of more than one ice-epoch began to receive careful attention, the drift of opinion seems to have been towards its acceptance, both in America and in Europe. So far has this gone, that in a paper just published, Prof. James Geikie goes to the extreme (as it would seem to many) of mapping the ice of the fourth glacial epoch in Europe, and believes there was at least a fifth. In this particular therefore, the volume can hardly be said to represent "the present state of progress."

In the course of his consideration of the arguments for two glacial epochs, Prof. Wright indicates that the oceanic waters probably reached southern Illinois and Indiana during the time of loess deposition, (p. 120). How this conclusion is reached we are not told. The fossils of the loess would seem to be conclusive evidence against it. We are further told, (p. 113) that the probable cause of the ice-epoch was a late Tertiary or post-Tertiary elevation. While this is a common view, there seem to us to be unanswered and unanswerable arguments against it, and if we are not mistaken the present drift of opinion is away from it.

In this connection, too, we have a strange "well-known law of parsimony" stated, a law "which requires us in our explanation of phenomena to be content with the least cause which is sufficient to produce them," apparently without regard to its truth. This is certainly a curious law.

In the chapter on drainage systems in the glacial period, we read again of the hypothetical glacial lake caused by the hypothetical ice-

dam at Cincinnati. We had supposed this notion nearly obsolete. It has been conclusively shown, so it seems to many geologists, that if the hypothetical ice-dam and its lake existed at Cincinnati, it could not have formed the terraces attributed to it, since they are not lake terraces. It has been further shown that the silts ascribed to the lake along the Ohio above the site of the alleged ice-dam, are continuous with like silts which occupy corresponding positions below the alleged ice-dam, and therefore were not deposited in a lake made by it. If, therefore, the Cincinnati ice-dam hypothesis survive, its supporters must needs find some new basis for it to rest upon, for a dam must have a foundation beneath it.

Prof. Wright seems to us often unjust to other American geologists. Some of these are ignored, even when their work has a direct and important bearing upon the subject under discussion. In some cases they are misquoted or misinterpreted, or their work put in a false relationship. This is doubtless a no more serious charge than carelessness. But in some cases the carelessness goes so far as to be serious. For example: Pres. Chamberlin is quoted as "maintaining" that the ice-epochs were "separated by a period in which the ice had wholly disappeared from the glaciated area to the north," (p. 109). Chamberlin's printed statement on this point, in discussing the retreat of the ice after the first glacial epoch, is this: "How far to the north this retreat carried the margin has not yet been ascertained, but the growing tendency of the gathering evidence is to throw it farther and farther back, and it is thought to be quite safe to believe that it withdrew entirely from our territory, if not from the Canadian highland" (vol. I, Geol. of Wis., p. 271). The same author is again misquoted in connection with Prof. Comstock. These gentlemen have suggested that changes of latitude in past times may perhaps have been a cause of glacial climate in those regions which now possess a genial climate, supporting the suggestion by astronomical observations on actual variations in latitude in recent times. They have pointed out the importance of careful observation on this point in the future, and the need of most thorough investigation of the whole subject of pole movements. One or both of them have speculated concerning the climatic results which would have attended wanderings of the pole extensive enough to bring it down to Greenland. For this they are quoted (p. 307) as "maintaining" that the north pole "was somewhere in the region of central Greenland * * *" at the time of the glacial period.

Again, in connection with the references to the driftless area, (p. 103) the credit for its explanation, so far as it is explained, is attributed to Chamberlin. But Winchell and Irving had both urged some points in the accepted explanation before its fuller statement by Chamberlin, and to each belongs some part of the credit. The reference to the work of Mr. Leverett (p. 101) seems to imply that it is inconsistent with the work of Chamberlin, while in point of fact this work was inaugurated and directed by the latter, and some of the

preliminary determinations were made by him. The reference to the work of Whittlesey (p. 100) is such as to give the impression that he had fully understood and interpreted the "kettle range" of eastern Wisconsin. Col. Whittlesey was, we believe, the first to recognize its glacial origin, but we believe he did not go further. Many other illustrations of inaccurate statements of the views and works of others might be cited. These things are of importance to the public chiefly in showing the carelessness with which the book has been prepared.

It is no exaggeration to say that facts are no more carefully dealt with than authors. Of this, more than one instance has already been pointed out. We take space for but a single further illustration. This is the map of the Trenton gravels, and the statements concerning the Pleistocene formations along the Delaware. This is critical ground for the question announced in the title of the volume. The Trenton gravels are mapped as extending north-ward beyond the confines of New Jersey. They are mapped as extending something like ten miles below Trenton on the New Jersey side of the river. The Trenton gravels, properly speaking, do not extend north of Belvidere, where the terminal moraine crosses the Delaware. There is gravel in the Delaware valley north of that point to be sure, but it is of much later origin than that at Trenton. That at Trenton is of equal age with the gravel of the dissevered terrace reaching as far north as Belvidere, but no further. Its equivalent doubtless exists along the Delaware to the south. But it has not been defined. If the sand and gravel of the area mapped as Trenton gravel below Trenton be really its equivalent, then the area runs much further south. But we think Prof. Wright has given no attention to this question, and that he is not attempting a new mapping. The Trenton gravel was, we are confident, deposited not "when the ice had melted far back towards the head-waters of the Delaware" (p. 261), but during the last glacial epoch while the ice edge stood at Belvidere. Prof. Wright's conclusion as to the time of deposition of the Trenton gravels is forced upon him by his adherence to the doctrine of but one ice-epoch. There are the troublesome Philadelphia brick clays (Columbia) which even Prof. Wright recognizes as much older than the Trenton gravels, to be accounted for. If the two formations must be included within the limits of one ice-epoch, it is no wonder that the origin of the latter is assigned to a date much later than that of the moraine, even if the facts of their stratigraphy must be neglected to get them there. There is really no area with which we are familiar where the evidence for more than one ice-epoch during the glacial period is stronger than in the Delaware valley. If Prof. Wright does not see it there, he is not likely to see it elsewhere.

Such an expression as "glaciated driftless area" and such a statement as that "the transporting capacity of water is in inverse ratio to the sixth power of its velocity" (p. 53), are to be noted only to secure their correction in future editions. They are mere slips. Perhaps the reference (p. 69) to "gneiss," "containing beautiful crystals of porphyry" belongs in the same category.

In two places our author makes claims which we think are not justified. The statement (p. 212) that "during the summer of 1882, I discovered the existence of unmistakable glacial deposits in Boone county" (Ky.), seems hardly consistent with the earlier published descriptions of the Boone county drift by Messrs. Sutton and Warder. From these authors, Prof. Wright himself quoted in 1884. Again (p. 62), our author says, "I have traced this limit of southern bowlders for thousands of miles across the continent, according to the delineation which may be seen in the map in a later chapter." This is certainly an unscientific exaggeration.

If we turn to the anthropological or archaeological side of the book, we find the discussion very brief, so far as glacial man in America is concerned; properly so, since the evidence does not appear to be voluminous. Our author's conclusion is, that paleolithic man existed in America during the glacial epoch. It is not represented that this conclusion is questioned, or that it is open to question. The evidence is regarded as sufficient. Even if this conclusion seems to the author warranted, it would have been but just to his readers and to archaeologists, who hold different views, had the author stated that there is a growing feeling that the evidence of glacial man is not beyond question. So far as America is concerned, the evidence of "paleolithic" man, glacial, pre-glacial, or post-glacial, is now looked upon by many as extremely suspicious in character, as well as meagre in quantity.

With reference to the "paleolithic implements" which are thought to prove the existence of glacial man, two or three troublesome questions have been raised, none of which Prof. Wright considers. Implements and works of art may be introduced into gravel by various processes, after the gravels themselves have been laid down. Were the "paleolithic implements" so introduced? This is a geological, not an archaeological question. Expert geological testimony that the "implements" are so associated with the gravel as to prove that they were introduced into it during its deposition in glacial times, is not forthcoming. If they were introduced later, the supposed proof of glacial man is gone.

So far as this line of evidence is concerned, recent investigation seems to indicate conclusively that the "implements" of another locality cited by our author, were introduced into the glacial gravel in post-glacial times. Perhaps the same may have been true at Trenton. There is a growing conviction that such may have been the case. It is not regarded as certain, therefore, that the "implements" at Trenton, are of glacial age. In the second place there is a question as to whether they are "implements" at all. And yet again, it is doubted whether they are "paleolithic." As the matter now stands the Delaware valley "implements" therefore, cannot be said to prove the existence of glacial man, or even of "paleolithic" man. The case is no better if we turn to the other localities cited. Of these newer questionings and conclusions we find nothing. On this point the author has not fulfilled his purpose of giving the general public "a clear

view of the present state of progress in this one department of the inquiries concerning man's antiquity."

We do not wish to be understood to call in question the veracity of those who have reported "implements" in glacial gravels. We have no reason to doubt that their conclusions have been honestly stated. But they may have been in error in thinking the gravel, containing the works of art, undisturbed.

Enough has been said to show that in "Man and the Glacial Period," facts are loosely dealt with, that authors are loosely quoted, and sometimes misquoted, and that interpretations are sometimes given without question, when the evidence does not warrant them.

University of Chicago, Nov. 15.

FRONDESCENT HEMATITE.

By N. H. WINCHELL, Minneapolis.

PLATES II AND III.

In the April (1892) number of the GEOLOGIST, Mr. W. S. Gresley gave an illustrated description of a "peculiar phenomenon in hematite," derived from some mine in the lake Superior region to him unknown. The fibrous structure of the ore suggested the name *wood iron ore*, although it was not supposed that the ore resulted from fossilization of wood. Mr. Gresley called particular attention to the peculiar holes seen passing through the specimen there photographed, this being the chief feature of interest.

Recently a larger specimen of the same form of dense hematite has come under the writer's notice and the accompanying plates (II and III) are reproductions about two-thirds natural size from photographs of the opposite sides of this specimen. It is said to have come from the Vulcan mine, Michigan, and is one of the finest of its kind. Referring to the very full and accurate descriptions of the physical characters by Mr. Gresley, every feature he has mentioned, so far as noticed, appears on this specimen, but in addition there is a larger number of the peculiar channels piercing this mass, and there is a further development of the radiating filaments or fibers which, in their completion in frond-like growths, indicate the relation of these channels to the process of development. It appears that in the process of increase these fibers, starting from different but slightly distant points, and having a tendency to expand by multiplication, the growths soon

FRONDESCENT HEMATITE.

FRONDESCENT HEMATITE. OBVERSE OF THE SPECIMEN SEEN IN PLATE II.

began to interfere with each other. The line of contact, which became a plane as the growth continued, is marked by the more or less distinct plane of separation, the position of which can be seen in the surface lines extending from these channels upward, or in the direction of increase of the mass. Following these fibers upward to their summits, they are seen to spread out like some frondescent vegetable growths, thus illustrating the tendency of inorganic matter to simulate the forms seen in organic. This is a familiar fact, and is witnessed in frost on window-panes in winter and in dendrites in the crevices of rocks, as well as in some agates and chalcedony. Some ludicrous mistakes have been made by microscopists in referring such shapes to organic causes, both in the crystalline rocks and in meteorites.

The principal problem, however, touching these hematite masses, consists in the existence of these channels which maintain their forms and in the main also their direction through the mass. They were supposed by Mr. Gresley possibly to owe their existence to the removal of some object round which the hematite had grown, but it appears to the writer that they date from the time of the development of the crystals, and are normal and natural. Their courses can be seen in plate III, and their relations to the growing fibers can be seen in plate II. While they run, in general, about perpendicular to the fibrous structure, they vary from that direction, and their shapes are also various. They are always placed in such positions that they lie in or across the planes of contact of two opposite-spreading frondescent growths, and in some cases they are at the lower extremity of such contact planes. It appears as if in the first instance they mark the vacancies left by the first contacts of over-arching growths from opposite directions, in the manner of aisles among thickly-set trees. The contacting branches then interfered with the free circulation of air, or whatever gases there may have been present, and interrupted and permanently stopped the development of those fibers which had what might be called their foliage and florescence beneath the over-spreading canopy. Once checked, and air currents established unfavorable to development, the crystallizing forces were powerless to fill the passage-way, and they were hermetically sealed over by the sub-metallic, nearly black hematite scale in which all the natural surfaces except the terminal fronds are encased.

ON PLEISTOCENE CHANGES OF LEVEL IN EASTERN NORTH AMERICA.*

By Baron Gerard De Geer, Stockholm, Sweden.

One of the most important principles upon which geology is founded is the theory of continental changes of level. The main points of this theory seem, in several cases, to have been well established by American geologists. Thus it has been pointed out, that to account for sandstone several thousand feet in thickness, and other deposits in shallow water, it is necessary to assume that the sea-bottom was sinking at the same rate that the sediment was accumulating. Again, as the continents in certain instances for long periods of time have not lost in hight, and this notwithstanding their immense denudation, they must have been gradually rising. It is also very generally admitted that many of the abundant alternations of strata deposited during different bathymetrical conditions, as well as the breaks between them, were caused by the oscillations of the earth's crust. In many instances, however, it cannot be decided whether the change of level was really due to movements of the land, or whether it was only the surface of the sea that rose and fell. Since the eminent Austrian geologist, E. Suess, in his grand work "Antlitz der Erde" has in a very ingenious way tried to refer most of the oscillations to the latter cause, denying the rising of the continents altogether, and since his views have been adopted by many geologists, it seems particularly desirable to get more positive facts for the final settlement of the question.

For the present at least it is hard to get such facts concerning the older formations, as they are very often eroded away to a greater or less extent and concealed by younger deposits. It is thus in most cases impossible to determine the original extent of a certain layer and especially of the sea in which it was formed. Consequently we cannot determine with sufficient accuracy in what way the corresponding geoid-surface has been deformed.

In regard to the Pliocene and Pleistocene formations it is of course less difficult, but in many parts of the world it seems as if the old shore-lines, which once marked the limit of these formations, were not very well developed or easily recognized. It

*From the Proceedings of the Boston Society of Natural History, vol. xxv. Awarded the first of the annual Walker prizes of the Society for the year 1892.

may sometimes be due to the fact that when the shores are low and consist of loose marine deposits, it is often very difficult to distinguish the new from the old formations, and also to ascertain the very limit of the last submergence. The beach is also easily effaced, partly perhaps through wind-blown sand.

In the glaciated regions, however, the conditions are often different and more favorable for the formation of enduring shore-lines, as the land is there generally covered with till and angular, stony debris, forming an excellent material for recording the action of the waves. Most of the old shores are described as situated in the glaciated regions, though this may perhaps partly depend upon another and deeper cause.

Although a great many marine shore-lines, shell deposits, and sediments of Pleistocene age have been leveled in Europe and America, it is nevertheless very rare to find any methodical attempts to determine their very limit in a more accurate way.

As far as I can see, that described below is the most suitable and perhaps the only possible method for this purpose. I have tested it in the northern part of Europe during the last ten years and by way of comparison in the eastern parts of North America during the autumn of 1891. In this paper I shall especially describe and discuss the results of the last named investigations, but as these point to a very close analogy with the corresponding phenomena in northern Europe, it seems appropriate to give first a general view of the latter.

Investigations in Europe.

During the summer of 1882 I spent three months in Spitzbergen studying the glacial deposits and the raised beaches. Though these were very instructive for the study of the origin of shore-lines in general, the conditions were not favorable for an accurate determination of the uppermost marine limit, the land being rather mountainous, precipitous, and destitute of till.

Since that time I have used every opportunity to discover and determine the marine limit in Sweden. The method I have used is the following: On every locality, I start from the highest level at which undoubted marine deposits and fossils are found in that part of the country; with the aid of the topographic map I select above the named level a drift-covered hill of sufficient hight with moderate slope and with a situation as open as possi-

ble to the ancient water-body and as near as possible to a point previously leveled.

Above the water-laid clay and sand there is in most cases a belt of gravel, and still higher, where sediment is almost wanting, there are more or less conspicuous marks of erosion and water-wash up to a definite horizontal limit. In favorable localities this can be determined with an accuracy of from a few feet to less than one foot. Later on I will give a more detailed account of the methods I have employed for these determinations. I will only emphasize here that while geologists have too often measured the highest conspicuous shore-lines which happened to be developed in a certain locality, I have used such figures only for the first approximation and when nothing else was available. On the other hand, I have always tried to choose hill-slopes so uniform that evidently the till above the measured limit, had it also been submerged, must necessarily have shown traces of water action in addition to the assorted, washed, and rolled material below.

Up to the present time I have thus leveled the marine limit at about seventy different points in the southern and central parts of Sweden and in a few places in southern Norway. For northern Sweden I have three or four approximate but important determinations by Högbom, Svenonius, and Munthe. For the other parts of the Scandinavian region of uplift the uppermost marine limit is not yet determined, but there are in geological literature a great number of measurements of the hight of raised beaches and marine sediments, and from these I have tried to ascertain the highest available minimum figures for different tracts in the region. While they are only preliminary, they nevertheless point very clearly to the same laws for the upheaval of land that I found to prevail in Sweden and it seems allowable to use them for the present, of course with due reservation, as the principal conclusions drawn from them will probably not be essentially changed by future more accurate determinations.

To get a general view of the warping of land since the formation of the marine limit I have used the graphic method of Mr. G. K. Gilbert (see his admirable work on Lake Bonneville) and have connected with lines of equal deformation, or as I have called them *isobases*, such points of the limit as were uplifted to the same hight.

Among the results of the investigation the following may be mentioned as being of especial interest for comparison with the conditions in North America.

All the observations evidently relate to one single system of upheaval, with the maximum uplift in the central part of the Scandinavian peninsula, along a line east of the watershed, or nearly where the ice-sheet of the last glaciation reached its greatest thickness. Here the land must have been upheaved somewhat more than a thousand feet (more than 300 meters), and around this center the isobases are grouped in concentric circles, showing a tolerably regular decrease in hight in every direction toward the peripheral parts of the region, until the line for zero is reached, outside of which no sign whatever of upheaval is to be found.

The considerable hight at which the uppermost marine marks are found, and the places where they occur, in the central parts of the land, show at once that no local attraction of the land ice could have been sufficient to raise the water to any such amount, had the ice been many times as thick and extensive as it probably was even at its maximum. Such an explanation seems less possible, as there could be very little room for any attracting land ice when the sea covered the parts of the land mentioned above.

But as no local changes of the sea level can account for the phenomenon, so it is also impossible to explain it by the general oscillations of the sea, either from the one hemisphere to the other, produced by changes in the situation of the center of gravity of the earth—according to the assumption of Adhémar and Croll—or by oscillations to and from the equator caused by changes in the rotation of the earth, as has been supposed by Swedenborg and Suess. If this theory were true, all the shorelines would slope in a single direction, but as they in fact slope as well to the south as to the west, north, and east, it is evident that the phenomenon must be explained by a real rising of the land.

Moreover the region of upheaval is practically about the same as that of the last glaciation; especially is it worthy of notice, that the maximum of both seems to have occupied about the same place.

Still more remarkable is the coincidence of the uplifted area

with the Scandinavian azoic region, or what Suess has called "the Baltic shield." This comprises Sweden, Norway, Finland, and the Kola peninsula, or a well defined tract where the old rocks are laid bare by erosion and the surrounding lands thickly covered with younger sediment. The limit of the Baltic shield, where it has been directly observed, and perhaps everywhere, is marked by great faults. Now the isobase for zero, or the boundary for the uplifted area, seems all the way a little outside of the above named limit and follows very conspicuously its convexities and concavities. Likewise all the other isobases point to a close connection between the upheaval and the geological and to a certain extent the topographical structure of the land. Thus it is commonly found that higher tracts have been raised more than lower; and the basins of the great Swedish lakes, Wener and probably also Wetter, have been less uplifted than their surroundings, which might indicate that they were originally more depressed and very probably formed by unequal subsidence.

The coincidence between the areas of erosion, glaciation, and upheaval may be thus explained: as in continental areas in general, this old tract of erosion has probably in the main been one of upheaval, while the contrary was the case with the surrounding regions, where the sediment was accumulating to a very considerable extent. During the ice age, among other high lands, the Baltic shield received an ice-sheet equal in weight to more than a thousand feet in thickness of the rocks which had been eroded away during previous periods. As Jamieson long since suggested, it is very probable that the crust of the earth must yield and subsidence of land take place beneath this added load. Therefore it is reasonable that the movements in the crust should be very much dependent upon its geological structure.

When the ice-load disappeared, the land partly re-emerged, until a balance was reached, which seems to have happened before the original hight was attained, a part of the change having become permanent.

If the ice-load was the essential cause of the submergence, a still larger subsidence must be supposed to have followed after the earlier and greater glaciation. It is true that very few traces of unquestionable interglacial marine deposits have been found, and that these are all along the boundary of the late glacial re-

gion of upheaval, or in southern Denmark and along the Baltic coast of Germany; but this is just what would be expected.

Then, as Dana first pointed out with reference to the fjords as submerged river-valleys, the land had probably in the beginning of glacial time a much greater elevation than at present. Thus it is quite possible, that during the great glaciation a considerable subsidence from the highest elevation occurred, followed during interglacial time by a partial re-elevation of the land; while the early marine deposits during the late glacial subsidence might have been a second time so deeply depressed below the sea-level that generally they have not since been uplifted sufficiently to appear above it. According to this explanation, it is easy to conceive why the interglacial marine deposits are accessible just in the tracts which were least affected by the late glacial subsidence.

I take this opportunity to remark that in my opinion the marine sediments which Murchison, Verneuil, and Keyserling* found at Dwina and Petschora in northern Russia, and which have been lately traced over large areas by Tschernyschew,† are probably of interglacial age, though they are not covered by till, as occurring at the outside of the last glaciation. But as their fauna contains such boreal and southern species as *Cyprina islandica* and *Cardium edule*, it is not probable that they could be contemporary with the arctic fauna of the late glacial subsidence in Scandinavia. On the other hand, it is difficult to believe that the considerable oscillation of land in northern Russia could have taken place so lately as in postglacial time. Hence there is some reason to infer that the deposits in question belong to the interglacial period, and it is my opinion that, like the undoubtedly interglacial deposits before-mentioned, they are still accessible above the sea-level only outside of the region which was affected by the late glacial submergence.

Before leaving the changes of level in Scandinavia I must add a few words about the latest oscillation, though this is not yet quite so well known, and can only to a certain extent be compared with the conditions in America.

After the late glacial upheaval in Scandinavia had proceeded

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*Murchison, Verneuil, und Keyserling, Geologie des europäischen Russlands; bearbeitet von G. Leonhard. Stuttgart, 1848, pp. 348-351.

†Th. Tschernyschew, Travaux exécutés au Timane en 1890; Petersburg, 1891, pp. 27, 52.

so far as to isolate the Baltic basin from the sea, thus forming a lake with a true fresh-water fauna, characterized by *Ancylus fluviatilis* Linné, and after this lake, following the general unequal movement of the region, had been partly emptied, then, as I have succeeded in showing, a new subsidence of land occurred, by which the outlets of the *Ancylus* lake were changed to sounds; and a marine though scanty fauna migrated into the Baltic. The deposits formed along the Baltic, as well as along the western coasts of the land during this last subsidence, are now partly uplifted, less in the peripheral and more in the central part of the region, but nowhere more than 200-300 feet above the sea level. They contain a true postglacial fauna, with many southern forms which are never found in the late glacial beds. Between these two marine deposits, peat bogs, river channels, and other traces of erosion are observed in many places in southern Sweden, showing conclusively that at least this part of the land was uplifted between the two subsidences. Several of these peat bogs and river channels continue below the level of the sea, and such signs of submergence are also found at the southern shore of the Baltic and around the North sea.

It is not yet possible to say anything with certainty about the nature of this last oscillation; but while there seem to be some difficulties in such an explanation, it may be possible that we have to deal here only with oscillations in the situation of the pivot point of the crust-movement or the isobase for zero. Professor N. S. Shaler has suggested,* that while the continents are, as a rule, rising, and the sea-floors sinking, yet it may happen that the pivot point, when it lies somewhat at the inside of the shore, will take part in the sinking of the sea-bottom, and then it will seem as if the continent were sinking, though in fact it may very well be rising in the interior. If it should turn out that this ingenious explanation could be applied to the Scandinavian oscillations of land, then the whole phenomenon would be more easily understood; according to this theory, in the center of the region after the removal of the ice-load a constant rising of the land occurred, and at the same time probably a sinking of the surrounding sea-bottom, in which latter movement some portions of the land for a time took part during the postglacial subsidence.

* "Recent changes of level on the Coast of Maine." Mem. Bost. Soc. Nat. Hist., Vol. II, p. 337, 1874

After that, the portions mentioned began again to participate in the great continental upheaval, which seems to be still going on, though probably at a much reduced rate.

Investigations in North America.

Observations.

The very interesting and valuable investigations of Gilbert, Upham and Spencer, have shown that the shore-lines along the great lakes in the interior of eastern North America have been unequally uplifted more toward the north than toward the south, and this seems to be quite in accordance with the generally adopted opinion in regard to the marine deposits along the Atlantic coast. This opinion seems to have been founded principally upon the different hights to which marine shells could be traced in different tracts, this kind of evidence being the most indisputable, though on the other hand affording only minimum figures. Concerning other proofs, as shore-lines, terraces, deltas and sediments of supposed late glacial age and marine origin, the opinions of different authors have been much more divergent.

As examples of this diversity of opinion the following figures may be quoted; a few only refer to shell localities.

In his Manual of Geology (1863), J. D. Dana mentions for the highest marine deposits:

South of New York, seldom over	10-15 feet.
At Brooklyn, Long Island	100 "
In Southern New England	30-35 "
In Maine, not more than	200 "
At Lake Champlain	468 "
At Montreal, above Lake St. Peter	470 "
In Barrow's Straits	1,000 "

In N. S. Shaler's paper on Recent changes of level in Maine (1874), we find for

New York City	a few feet.
Deer Isle, in Maine, at least	200 "
Belfast, " about	250 "
Between Milbridge and Machiasport, at least	100 "
At Labrador, "	1,000 "
On the Greenland Coast "	2,000 "

The same author in later papers assumes for

Nantucket Island (1889), at least	300 feet.
Cape Ann (1890)	130-150 "
Mount Desert (1889)	1,300-1,500 "

W. Upham mentions in the appendix to Wright's work on the Ice Age in North America (1889), for

Boston and northeast to Cape Ann, probably not more than	10-25	feet.
Maine (Stone) about	225	"
Nova Scotia and Cape Breton Island	wanting.	
Bay Chaleur (Chalmers) not more than	200	feet.
Opposite Saguenay (Chalmers)	375	"
Montreal (J. W. Dawson)	520	"
About 130 miles W. S. W. from Montreal (J. W. Dawson)	440	"

J. W. Spencer, in a paper on Post-pleistocene subsidence *vs.* glacial dams (1891), claims as marine and as belonging to the same submergence all the beaches and terraces along the great lakes, as:

On summit east of Grand Traverse Bay, Mich. (Rominger)	1,682	feet.
W. from Collingwood at the Niagara escarpment	1,200-1,425	"
At Dog Lake (H. Y. Hind)	1,425	"
In Potter County, Western Penn., a low gravel ridge *	2,660	"
At the Upper Potomac, terraces with rounded boulders (I. C. White)	1,675	"
Nachvak, in Labrador (R. Bell)	1,500-2,000	"
In Vermont (Hitchcock)	2,300	"

From erratics on the top of mount Washington, 6,300 feet, and on mount Katahdin, 4,400 feet, the author concludes that the subsidence extended so far and was greater there than in Labrador.†

F. J. H. Merrill gives, in his Postglacial history of the Hudson River valley,‡ the hights of several delta deposits and plains which he considers marine:

* Considered a kame by H. Carvill Lewis.

† It may be mentioned here that the silt and terrace deposits, 3,000 feet above sea level, which Spencer mentions from Norway as proof of an analogous great submergence, are certainly not of marine origin, and are most probably analogous to the "parallel roads" in Scotland. They are known in many localities in the higher valleys of Norway and Sweden, but there is not one Scandinavian geologist who considers them as marine; the well marked marine area is much lower.

‡ Am. Jour. Sci., III., vol. XLI., June, 1891, p. 462.

At New York	80	feet.
Mouth of Croton River	100	"
Peekskill	120	"
West Point	180	"
Fishkill	210	"
Schenectady	340	"

As some of the above figures seem difficult to reconcile, and as the marine origin of several of the deposits seems also questionable, I have thought it useful to make another series of observations, and have employed the same methods which I used in Scandinavia.

Perth Amboy.

During a short visit made in company with professor Smock to Perth Amboy, southwest of New York city, just where the great terminal moraine reaches its southernmost point in this tract, I could not find on the surface of the moraine any traces of marine erosion above the well developed terrace at the present sea-level.

New Haven.

At New Haven I had an opportunity, during an excursion with Prof. J. D. Dana, to see the lowest of the late glacial river-terraces or flood-plains so admirably described by him, with their remarkably well preserved kettle holes, but without any traces of former shore-lines. At the same time I visited the present seashore at West Haven in company with Mr. H. Lundbohm. The even flood-plain descends with a continuous slope to the very edge of the actual shore-terrace or to a level about 17 feet above highwater mark. On the surface of this terrace there lies exposed in the cliff an earthy bed one or two feet in thickness, containing shells of oysters and *Venus mercenaria* which no doubt formed an Indian kitchenmidding and show that since its formation the terrace has been cut back. The foot of the cliff lies about three feet above what I assumed to be the ordinary highwater mark and evidently represents the actual storm-level. These facts seem to be in accordance with the assumption that this coast is slowly sinking, and I failed to find any proofs that since the Ice age the land was ever more deeply submerged than it is now. As the original land surface here is cut away by the recent wave-action, this locality does not prove anything for levels lower than 17 feet. Thus, though it cannot be denied that

there might have been, as professor Dana has suggested,* a subsidence about 10 or 15 feet below the present level, it appears that even this slight amount cannot be allowed until a series of measurements in different localities gives closely corresponding values for the extreme marine limits.

Martha's Vineyard.

On Martha's Vineyard, where I had the advantage of Prof. N. S. Shaler's guidance, I could only confirm his observation that no raised beaches of any kind were to be seen. Where the terminal moraine touches the flats of Tertiary clays, the topographical features are sometimes at a distance terrace-like, but no true marine terraces either cut or built could be observed. So complete indeed is the preservation of the topography from marine erosion that professor Shaler, who has thoroughly investigated the island, has come to the conclusion, that if this tract has been submerged it must have been uplifted quite suddenly. But it seems unnecessary to make use of this explanation; for while I have not seen many of the kames in this locality, I should imagine that it would be easier to account for their ridge-like, winding shape, if we assume that they, like the ordinary osars, originated between walls of land-ice or possibly in some cases of river-ice and snow. If they had been deposited in the sea it would appear that the shape should have been more like a delta or a built terrace. As to the submerged valleys on the southern side of the island, these might also be most readily explained by supra-marine erosion of glacial rivers; for if they were formed below the sea-level, by bottom-currents, coming from the mouths of sub-glacial rivers, we might expect them to be broadest and deepest at their beginning, whereas on the contrary they regularly increase in size as they depart from the terminal moraine. Moreover it seems scarcely probable that such currents could have kept together for more than five miles, and it is specially difficult to account for the fact that all the small tributaries come in at great angles. Furthermore, I may remark that all the glacial rivers that I have observed in Spitzbergen pour out their muddy waters as a thin layer on the surface of the sea, even in the interior of the fjords, where the sea-water is probably much less salt than on the open glacial coast of Martha's Vineyard.

* "On Southern New England during the melting of the great glacier." Am. Jour. Sci., III., vol. X., Dec., 1875, p. 434.

Both at Vineyard Haven, Martha's Vineyard, and at Wood's Holl on the mainland, the actual shore-terrace is very well marked and the beach is covered with numerous residuary boulders, while the cliffs often consist of unwashed till, which has evidently never been submerged.

Boston.

In the neighborhood of Boston I made excursions in company with Mr. Warren Upham and examined especially the surfaces of several drumlins without being able to see any traces of marine action above the foot of the hills, some 10 or 20 feet above the marshes. At the marsh level north of Powderhorn hill in Chelsea we visited a claypit showing to a depth of more than 10 feet a fine laminated clay with occasional drifted boulders, probably of marine deposition.

One day in company with Prof. W. O. Crosby and Mr. Lundbohm we studied several terrace-like benches on the sides of several drumlins which had been previously observed by professor Crosby; but as we found that they had sometimes a considerable slope, perhaps 1:10 or 1:20, and were not developed in the greatest degree on the sea side, we agreed that they could not be of marine origin.

Though the marine terraces cut in the drumlins along the actual shore are very sharply marked, their cliffs 100 feet high and their bases covered with residuary boulders, it might seem possible that terraces cut in such a loose material would not be preserved from slipping down for any long period. Nevertheless the presence of benches on the drumlins at Boston, as well as the very conspicuous cut-terraces in drumlins at the late glacial Iroquois beach on the south side of lake Ontario, makes it very probable that if the land at Boston had really been submerged to a great depth, the limit of the marine erosion at least, and perhaps several lower levels also, would have been recorded on the drumlins by shore-lines easily distinguishable in many places, though perhaps somewhat downfallen. I am therefore quite of Mr. Upham's opinion that the subsidence at Boston was slight. In full accordance with this is professor Crosby's statement, that while the till in the Boston basin consists in great part of fine, clayey material, the wide-spread modified drift above the marsh-level contains nothing but gravel and sand, thus indicating that above this level there was no large water body where the finer sediment could be deposited.

Mount Desert Island.

I am very much indebted to professor Shaler for his kindness in accompanying me to Mount Desert and in introducing me to the interesting geology of that island. During our two days' excursion I had several opportunities to observe that, as professor Shaler's map shows, the glacial, probably marine sediment, and the gravel and sand as well as the clay, were to be seen only on the lower parts of the island, probably up to about 200 feet.

The first point where I saw anything like the marine limit was two miles northeast of Somes sound, just east of the *trivium* on the western slope of McFarland's mountain. Up to an apparently horizontal line the soil was covered with residuary boulders, but just above it unmodified till was exposed at the side of the road. The approximate hight of the shore-line was according to the aneroid c.* 204 feet (62 m.), and according to angles measured to the surrounding mountains c. 216 ft. (66 m.) + 12 feet.

East of Somes sound, in the pass between Brown's and Sargent's mountains, at the hight of between 330 and 200 feet no traces of marine action upon the till were seen, though the southern slope must have faced the open Atlantic, if this ever reached so far; but as soon as we came down to the 200 foot contour line, well washed and assorted material occurred abundantly as a gravel-bar east of Haddock's lower pond. I had not time to fix the actual limit at this locality, but the approximate hight of the bar was according to the aneroid c. 190 feet (58 m.).

The curious rock benches seen at many places on the slopes of the granite mountains seem to be very closely connected with the occurrence of vertical and horizontal joint lines in the rock; we visited several of these on Jordan's hill, Sargent's mountain and "the cleft." Level benches are often formed by weathering where rocks are horizontally jointed, so that this important characteristic of marine action in other cases is in itself of no value here, unless other common shore features, as beaches with water worn pebbles and ordinary cut and built terraces of drift, together with marine sediment, can be shown to exist. Furthermore in several places the joints and the benches were inclined from 5° to 20°, and nowhere exhibited the characteristic and very regular appearance of the rock cut marine terraces in Norway and Spitzbergen.

On the open southern surface of Sargent's mountain we ob-

*Abbreviation of *circa* (about), noting an approximate measurement.

served numerous small patches of till, often with well striated stones; and numerous stones and much isolated debris occurred scattered over the surface in such a way that they must have been swept away very quickly by the waves from the Atlantic if they were ever submerged.

The remarkable overturned boulder which professor Shaler describes on the southern summit of Jordan's hill at an elevation of more than 300 feet does not seem in itself a sufficient proof of ice-shove from the sea and thus of submergence up to this level, as we cannot safely deny the possibility that it might have been overturned by the roots of a tree in a violent storm or even by the agency of man.

At the road on the southeast side of "the cleft," it looks as if the rocks had been swept bare by the sea up to about 200 feet, but we could not stop to ascertain with the handlevel whether this had been the case.

I stayed for a few days more to make further attempts in determining the marine limit.

About one and a half miles south of Bar Harbor, at the southern end of the 280 foot hill, I found a cut terrace, above which I could find nothing but angular stones, while on a level a few feet lower waterworn gravel and pebbles were plentiful, as on the top of the roadhill. Here, as in other places on the island at a somewhat lower level, the gravel overlapped the clay, having been brought into this position as shore drift during the successive upheavals of the land. The hight of the marine limit at this point as far as it could be ascertained was about 209 feet (c. 64 m.).

About one mile southwest of Bar Harbor and one mile E. N. E. of the northern end of Eagle lake, just above the covering of marine sediment, I found a little series of well developed beaches, of which the uppermost and largest, marked by a gravel pit, was situated according to the barometer at a hight of about 210 feet (c. 64 m.).

Finally I returned to the above mentioned point N. E. of Somes sound, where I first observed the marine limit, and made a more careful investigation. I followed the shore-line with a hand-level for nearly half a mile north of the road, finding the following differences, the absolute hight being measured with a barometer:

(*a*) Farthest to the north of the road	210 feet (63.5 m.).
(*b*) Midway between (*a*) and (*d*)	211 " (64.1 ").
(*c*) Nearer the road	213 " (64.4 ").
(*d*) Just north of road	213 " (64.5 ").
(*e*) South of road	209 " (63.4 ").

Fine unwashed till occurs in open situation immediately above this shore-line as well as north of the road.

As to places in other tracts where I have made determinations of the marine limit, I must for the present confine myself to a mere statement of the hights obtained, but I hope that I shall be able to add a more complete description of the different localities.

Determinations of the Late Glacial Marine Limit.

Localities.	*With handlevel.* Feet.	Meters.	*With barometer.* Feet.	Meters.	*Probable hight.* Feet.	Meters.
1. Perth Amboy, N. J.	—	—	—	—	0	0
2. New Haven, Conn.	<17	<5.2	—	—	c. 10?	c. 3?
3. Martha's Vineyard, Mass.	—	—	—	—	0	0
4. Boston, Mass.			—	—	c.10–20	c. 3–6
5. Mount Desert island, Maine.						
(*a*) N. E. of Somes Sound.	—	—	204	62		
(*a*) " " " "	—	—	208	64	c. 210	c. 64
6. (*b*) S. W. of Bar Harbor.	—	—	210	64		
7. (*c*) S. of Bar Harbor.	—	—	209	64		
8. Stockton, Maine.	—	—	274	84	c. 280	c. 86
9. Bucksport, Maine, at Fort Knox.	305	93.0	298	91	305	93
10. St. John, N. B. (*a*) western point.	—	—	267	82	c. 269	c. 82
11. " " " (*b*) eastern "	—	—	271	83		
12. Digby, N. S.	> 35	> 10.7	—	—	c. 40	c. 12
13. Annapolis, N. S.	42	12.7	46	14	42	12.7
14. Wolfville, N. S.	<49	<15	—	—	c. 50?	c. 15?
15. Moncton, N. B. (Berry Mill Station, I. R., being 208 ft.)	—	—	325?	99?	c. 325?	c. 99?
16. Bathurst, N. B.	—	—	196	60	c. 196	c. 60
17. Dalhousie, N. B.	175	53.4	175	54	175	53.4
18. Dalhousie Junction, N. B.	—	—	174	53	c. 174	c. 53
19. Rivière du Loup, Quebec (the Station I. R., 322.5 ft.)	373	113.9	—	—	373	113.9
20. Montreal, Quebec (a leveled point being 565 ft.)	—	—	625	190	c. 625	c. 190
21. St. Albans, Vt. (the station being 390 ft.)	658	200.5	656	200	658	200.5
22. Alburgh, N. Y. (Moira station, C. V. R., being 357 ft.)	—	—	662	202	c. 662	c. 202
23. Ottawa, near Kingsmere lake, Quebec (Hull st'n C.P.R.185 ft.)	—	—	705	215	c. 705	c. 215

Unless the contrary is stated all the above hights refer to high-water mark, and the uplifted shore-lines were probably formed at least at or rather above ordinary highwater. As the high tide might have been somewhat lower in the Bay of Fundy

when the submergence formed a narrow strait across the Chignecto isthmus the figures for the localities at St. John and in Nova Scotia are perhaps some 5 feet too high. If, as is probable, the levelings based upon railway altitudes refer to mean tide, they also must be lowered about 5 feet.

The levelings were all made with Swedish handlevels constructed by Wrede and Elfving, which contain a mirror held vertically by an adjustable weight and sheltered from the wind by a little wooden case. By aid of a scale angles can also be measured, and I have often made good use of them as a check and also for plane table work.

The barometrical measurements were made with two aneroids from Naudet in Paris, and each is based upon a series of 10 to 25 observations by means of which the changes in pressure during the day are graphically constructed, and from the differences thus obtained the hight is reckoned with due corrections for temperature. Though I have often in this way got remarkably good results, it is very desirable that these measurements should be checked by the spirit level, as figures should not be considered conclusive which have not an accuracy within three feet or about one meter.

Conclusions.

All the observations on the hight of the marine limit have been put down on a general map,* and with the aid of interpolation isobases have been drawn through equally uplifted points with an interval of 200 feet (60 m.).

Concerning the extension of the isobases into the interior of the continent, where the marine limit could not be directly determined, I have tried to use interpolation in the following manner. As has been stated, it is probable that the geoid-surface, which in the submerged regions is marked by the marine limit, is situated in the tract northeast of lake Ontario at a hight somewhat less than 75 per cent. of the older high-water level recorded by the Iroquois beach. From the figures given by professor Spencer† we find that this beach is situated at about 36 per cent. of the Ridgeway beach at the three localities where both occur

*Presented with this paper in the Proceedings of the Boston Society of Natural History, but not here reproduced.

†"High level shores in the region of the Great Lakes and their deformation," Am. Jour. Sci., March, 1891.

near each other. Consequently the geoid of the marine limit should be found at 27% of the latter beach, if the deformation of both had been proportionate.

To see to what degree this has been the case for the different beaches, I have also reckoned in percentages the proportion between the Forest, Ridgeway, and Maumee beaches and from the figures thus obtained as far as we can judge from the material at present available the differential uplift of the highest or the Maumee beach was somewhat greater than that of the Ridgeway beach, the same being the case with the Ridgeway beach in comparison with the Forest beach, but the lowest one, or the Iroquois beach, seems to have a proportionately steeper slope than the Forest beach and to be in this respect more proportionate to the Ridgeway beach.

As this has been explored for the greatest distance and seems to be the easiest of identification, I have thought it advisable to use it for this preliminary interpolation, without attempting to make any correction for the divergence from the proportion of 27% which may occur in the southern part of the region.

Thus of the figures on the map indicating the interpolated hight of the marine limit, all those along the Iroquois beach represent 75% of its hight, and those along the Ridgeway beach 27% of its hight.*

Concerning the westernmost part of the glaciated area we owe accurate information about the gradient of the warped beaches to Mr. Warren Upham's excellent investigation of lake Agassiz. However, until the deserted beaches around lake Michigan and lake Superior are more fully explored and the damming ice-border is continuously traced between the different basins, it is difficult to form any opinion about the absolute amount of the upheaval of the land since the formation of the marine limit.

In the meantime we must content ourselves with the following facts. As Prof. J. E. Todd and Mr. Upham have stated, the deserted shores of lake Dakota, situated close to the southwest of lake Agassiz, show no or only a slight unequal deformation.

*This method of interpolation can of course be accurate only when the change of level has been successive and regular, as may perhaps to some extent have been the case with the sea, but probably much less with the ice-dammed lakes. Still the present state of our knowledge does not seem to allow any more satisfactory method, and this may be sufficient for the present purpose.

As the longer axis of this lake trends in nearly the same direction as the greatest warping of lake Agassiz, it seems probable that the limit for this warping and at the same time for the upheaved area lies just between lake Agassiz and lake Dakota or through lake Traverse. It is by no means certain that the limit for the uplifted region or the isobase for zero remained at the same place when the marine limit in the St. Lawrence valley was formed; but we may assume it for this part of the continent, since we cannot, at present, expect to get more than a general idea of the direction of the isobases and their maximum gradient. To judge from the probable thickness and direction of the receding ice-border, it appears that the formation of the highest or Herman beach of lake Agassiz was probably antecedent to the geoid surface which is traced in this paper. Moreover, it is quite possible that the ice had not receded from the St. Lawrence valley before lake Agassiz received the northward outflow. Yet to be quite sure of maximum figures for the gradient, I have used the measurements of the highest or Herman beach, though they may be too high.

As to the probable position of the marine limit in the other northern portions of the area very little can be added. Some explorers, believing that every kind of drift is deposited in the sea, have not paid due attention to the determination of the limit for the real marine deposits; others seem to have estimated only the hight of beaches accidentally discovered and their most reliable observations are made with a barometer often at a long distance from any known level or base-barometer.

From Murray's paper on the glaciation of Newfoundland* it seems that marine deposits are found on that island at a hight of about 200 feet. According to R. Bell† distinct beaches are seen at Nachvak in Labrador at an estimated hight of 1,500 feet; but I have not found more precise measurements for these tracts. Even if this measurement should be over-estimated, these beaches may be among the highest in all the uplifted area. But the low levels at which marine deposits are found in the relatively well-explored southern and western parts of Greenland, make it improbable that the extraordinary high levels, reported as occur-

*Proc. and Trans., Roy. Soc. Can., 1883, I, pp. 55-76.

†Rept. Geol. Surv. Can., 1885, p. 8 DD; and Bull. Geol. Society of America, 1889, vol. I, p. 308.

ing along Smith sound, should belong to the same system of upheaval as that of the Canadian region.

East of the middle of Hudson bay between the coast and Clearwater lake. A. P. Low has found sediments and terraces probably of marine origin up to about 675 feet above sea level.*

Southwest of James bay, on the Kenogami river, a tributary of the Albany, Bell † has found marine fossils about 450 feet, and west of Hudson bay at Churchill river about 350 feet above the sea level.

As is easily seen from the above statements, the observations at present available do not allow the drawing of even approximate isobases over a large portion of the area: but from the part sufficiently studied, it seems possible to form a general idea concerning the nature of the changes of level: these point to a remarkable analogy to the conditions in Scandinavia. Thus the greatest subsidence has taken place in Labrador—probably near the watershed—where the ice accumulation had its center. But as the ice in the northern part of this land, according to Bell, had a northward movement, it will probably be found that the amount of subsidence also decreases to that side, about as it did in all other directions in which the ice-covering thinned out.

The conformity between ice-load and subsidence seems to have been still greater here than in Scandinavia, and in this respect it will be very interesting to see what will result from a continued investigation of the warped beaches in the lake basin with its marked ice lobes. It can already be seen that the isobases in the peninsula southeast of the St. Lawrence river, which we will here for brevity's sake call the Atlantic peninsula, follow very closely the extension of the last glaciation. Especially is it noteworthy that the amount of subsidence was small along the gulf of St. Lawrence in connection with the fact, stated by Chalmers, that the ice thinned out in that direction.

Nova Scotia, which probably only in its western portion and to a small amount participated in the subsidence of the mainland, seems not to have been wholly ice-covered during the last glaciation, and the local glaciers might not have been thick enough to produce any noticeable changes of level.

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*"Rep. on expl. in James Bay and country east of Hudson Bay," Geol. and Nat. Hist. Surv. Can., Ann. rept., 1887, vol. III., p. 59 J.

†Geol. and Nat. Hist. Surv. Can., Ann. rept., 1886, vol. II., pp. 34, 38 G.

The gradient of the deformed geoid surface was evidently steepest on the Atlantic side of the continent, where the slope of the ice-sheet must also have been greatest: it is here generally 1: 1,400, with the exception of the St. Lawrence valley, where its direction is oblique to its general trend against the Atlantic and its amount is not larger than about 1: 4,900.

The steep gradient will probably be found also at the coast of Labrador, which in many respects is analogous with the high, fjord-cut coast of Norway in Scandinavia. In the interior of the American continent, where the ice spread out over a large area, the isobases are far more distant and show a smaller gradient just as in Scandinavia. Thus the mean gradient from Georgian bay towards the southwest to the limit of the area seems about 1: 3,400, being much steeper at the border of the azoic region and smaller at the outside.

The connection between the subsidence and the geological structure of the earth's crust is perhaps not quite so striking as in Scandinavia. Still it seems probable that the Canadian azoic or Archaean region has changed its level more than the surrounding tracts, though this is not yet sufficiently proved in regard to Hudson bay. The general conformity between the ice-covering and the old azoic plateau makes it difficult in the present state of our knowledge in many cases to discern between the influence of these two circumstances. Thus it may be remarked that the above mentioned convexity of the isobases around the Atlantic peninsula may also have some connection with the Atlantic mountain ranges, and that the most uplifted part lies near the Adirondacks, consequently at quite a distance west of the ice-shed at Quebec. The fact that Newfoundland, which at least during the last extension of the glaciers may have been only locally glaciated, also shared in the submergence may in some degree be accounted for by its geological structure.

All the above statements concerning the late glacial upheaval are based upon the hight to which the marine deposits are uplifted, but as we generally cannot tell whether this rising of the land has been continuous or partly counteracted by subsidence, it would be more correct to speak of it as the final result of the changes of level since the maximum of the late glacial submergence.

Along certain parts of the Atlantic coast many facts were ob-

served long since which show that these tracts in very modern times have been and perhaps still are sinking, and it is of interest that these signs of subsidence are found along the Atlantic coast plain outside of the glacial region of uplifting as well as somewhat within its boundary, just as has been the case in Scandinavia. Thus submarine peat-bogs are known in New Jersey and Nantucket island as well as at the northeastern end of the bay of Fundy and at the mouth of bay Chaleur. These last localities show that if the rising of land is still going on in the interior, the isobase for zero, or, to use Shaler's expression, the pivot point between the continental upheaval and the oceanic subsidence, has moved at least more than fifty miles toward the land side. The amount of this subsidence is not yet known, but at the bay of Fundy it must have been at least 40 feet, and at Nantucket probably 10 feet. Even the numerous small partly submerged glacial river valleys at the southern shores of Cape Cod, Nantucket, Martha's Vineyard and Long Island, afford evidence of a slight submergence. The same is the case, as Merrill has pointed out, with the Hudson river estuary, which must have subsided somewhat since the channel was cut out of the glacial clays in the valley.

Another question is whether the deep submarine river valley southeast of New York harbor, so well described by professor Dana, belongs to so late a period. The fact that its upper end down to a depth of about 100 feet has been entirely filled up at the outside of Sandy Hook seems to indicate that the Hudson river leveled the adjacent part of the pre-existing channel during the maximum of the postglacial elevation, having its mouth here and not farther out to the sea for a considerable time. The other analogous submarine channel described by Dana from the north side of Long Island may perhaps afford a possibility of determining their age. Having crossed Long Island sound in an oblique direction, it becomes during the last 10 miles more and more shallow, ending abruptly at Long Island against the terminal moraine. Here it may be possible to ascertain with a few borings, whether the channel, as it appears, has been overridden by the moraines of the last glaciation, and perhaps also whether it is younger than those of the first glaciation.

Though the abrupt ending of this last channel is very likely due to the terminal moraine, which, to judge from Dana's obser-

vations, has not quite filled it up, yet there appears to be no continuation of it on the other side of Long Island, even beyond the glacial deltas.

This curious fjord-like shoaling of the submarine channel, before it reaches the edge of the continental plateau, is repeated by the submerged river channels described by A. Lindenkohl from the Delaware and Chesapeake bays.

This phenomenon might perhaps be explained according to T. F. Jamieson's suggestion for certain fjords, as a consequence of the unequal and intense subsidence of an ice-loaded continent.

But concerning these channels, as well as the one described by Chalmers in the St. John river estuary and the large channels reported by Spencer from the gulf of St. Lawrence and several other places, we must allow that at present we know very little indeed of their history and precise age, with perhaps the general exception that they may point to a high elevation in early glacial time.

In this connection it is of interest that in America as well as in Europe the interglacial marine deposits at present accessible above the sea level are found only near the margin and at the outside of the region, which, during the last glaciation, has been exposed to subsidence. I refer here to the interesting fossiliferous deposits described by Shaler, Upham and others, from Nantucket, Martha's Vineyard, Long Island and Boston. The question whether the Columbia formation belongs to the same subsidence cannot safely be discussed, before its marine origin is conclusively shown by fossils, boundary shore-lines, or other indisputable evidence. The same is true of the lower beds of sand and clay about 50 feet thick which Lyell in the report of his first voyage to North America describes from Beauport near Quebec. The clay with boulders, which he observed resting upon these beds and covered by fossiliferous, late glacial deposits, is, as I could myself ascertain, a true till, probably belonging to the last glaciation.

Though the situation of these possibly interglacial deposits is open to the St. Lawrence estuary, their marine origin is very questionable, since no fossils have been found.

But if it is difficult to get any idea of the interglacial geoid deformations from the marine deposits, it is still more so with respect to the scanty remnants of lake sediments. As compared

with these the buried river channels seem to be easier to trace, though, of course, affording less accurate information.

In this connection and as possibly pertaining to the general interglacial hydrography of the Great Lake basin, I may perhaps mention the common occurrence of waterworn pebbles in the drumlins west of Syracuse, as these may very likely be derived from buried shore-lines belonging to the same interglacial lake as the interesting deposits east of Toronto.

Finally I will emphasize, that the purpose of this paper is much less to give an ultimate solution of the different complex problems connected with the continental changes of level, than to show a way by which, I think, such a solution can be reached with as little loss of time as possible.

From the details already determined in North America as well as in Europe, it is evident that the changes of level are closely connected with the local structure of the earth's crust and with the local extension of the glaciations; and thus it is conclusively shown that no changes whatever in the level of the sea can account for the phenomenon.

Notwithstanding all doubts as to the possibility of vertical uplifts of the great continental portions of the earth's crust, we may already be fully justified to use about this with a new meaning the well known words of Galilei: "Yet it does move."

EDITORIAL COMMENT.

THE UNIT OF GEOLOGICAL MAPPING FOR STATE SURVEYS.

Referring to the communication of Prof. Winslow on the "Higginsville sheet of the Missouri Survey," in response to a review of the same sheet in the November number of the GEOLOGIST (p. 317), inasmuch as Prof. Winslow intends that his statement of principles shall be considered fundamentally applicable to "a general system of mapping of a state or nation," and thus to cover the subject, from his point of view, it seems proper that attention be directed to some considerations which are pertinent but which he seems to have forgotten or to have misapprehended—at least to have misapplied.

In the first place, although it might perhaps be inferred from

the "review" that our answer to Prof. Winslow's second question might be as he states it: "The size of the sheet shall be uniform, but shall not exceed a large quarto page in dimensions; that is, the maximum size shall be about 9x12 inches," that is not the answer which we should give to that question. We only wished to enforce the necessity of keeping the size of the sheets within the quarto size of the book. It is apparent to anyone that such sheets might be made to fold in the middle and upon insertion in the volume, on short "stubs," they might occupy two pages of the quarto size. Indeed, should it be necessary, the fashion which has been followed already many times by the annual reports of the United States Geological Survey could be resorted to, viz.: fold the sheet three times, once at the stub, in the center of the book, and once at the outer margin of each page. This would allow of a map nearly four times that of a single quarto page, and yet be within the quarto page sufficiently to meet the requirements of the "review." As much of Prof. Winslow's argumentation is based on the assumed inflexibility of the size of the map desired, it is apparent that it falls to the ground when its basis is removed. The other answers to the three questions propounded by Prof. Winslow we do not take any exceptions to. We would add, however, to the third answer, a proviso, viz.: that the maps should also be published, on the completion of the survey, in *atlas form*, accompanied by very short descriptive text, thus forming a geological atlas of the state, with accompanying commentary, uniform in size and style, with the regular volumes. This is all derived from the *book* side of the question.

In applying his arguments, however, Prof. Winslow overlooks an important minor consideration when he views the question from the *area* side. As the counties of a state vary often very greatly in size, so the scales of the separate maps must vary, and some of them would be so large as to be ludicrous and some so small as to be useless. Remembering that this argument is based on an assumed rigidity in the rule, which does not exist, it might also be remarked that, actually, the size of the inhabited counties in the various states, particularly of those that remain to be mapped, is pretty nearly uniform. The necessities of travel to and from the county seats, in the most of the states of the Union, and the requirements of county "home rule," regulate the size of the counties in all the "organized" areas of the Union. It is, of

course, for such cases that any scheme should be made applicable. If there be exceptions or irregularities, as in the case of "unorganized" counties, which are apt to be temporarily large, like the enormously large counties of northern Minnesota, there are various ways in which those maps can still be brought within the requirements of the "review."

1. They might be reduced to the minimum scale, particularly if their geology is unimportant, or largely unknown, like some of the drift covered counties of western Nebraska or northwestern Minnesota.

2. In extreme cases when important geology in an "unorganized" county must be delineated, or in an organized county too large for handling in quarto style as expressed above, it would be best to divide such area into two or more maps, numbered consecutively and so placed in the volume as to be of convenient reference.

3. In the case of very small counties, it is invariably the case that such are thickly inhabited, and then the greater usefulness and popularity of the maps would justify a larger scale than for the others. For instance, Ramsey county, the smallest in Minnesota,* embraces St. Paul, the capital of the state. There appears to be no unduly large scale in the plate map which shows its geology in the report of the Minnesota survey. (Final report, Vol. II, plate 43.)

4. If there be, in any state, several such counties, and it is thought best not to expand them over a quarto page in giving their geology, it would be a simple problem to so reduce them that two could be expressed on a single page, or at least on a folded sheet.

The devices that may be resorted to to embrace all the mapped areas within the sizes required by the "review" are numerous, and every geologist must employ them according to his particular conditions. It is not difficult to bring objections against any system of mapping, but it has appeared to us that those state maps that have adopted the county as the unit have avoided a larger number of complaints than the others.

We would add in conclusion, that we question the propriety,

*Prof. Winslow gives the extremes of county areas in Minnesota as 162 square miles and 5,880 square miles. They are actually 187.15 square miles (Ramsey) and 6,611.75 square miles (St. Louis). Final report, Vol. I, p. 114.

or perhaps the possibility, of embracing in one scheme of mapping, all the essentials which may be demanded in any "general system of mapping a state or nation." Maps are made for various uses, and under various auspices. The United States government would be justified in looking at this question from a different point of view from that of a state government, and might well choose a larger or smaller unit, or might ignore county and state boundaries.

THE TOPOGRAPHICAL WORK OF THE NATIONAL GEOLOGICAL SURVEY.

The article of Mr. Gannett, in response to our editorial in the November GEOLOGIST criticising the course of the United States Geological survey in entering upon and prosecuting the topographical work on which it has been engaged for ten years at the average rate of $215,000 per year, is intended, ostensibly, as an answer to our objections, but it falls short of its purpose. Our objections are stated near the close of the "editorial" categorically, and we respectfully refer Mr. Gannett to them, if he desires to try again.

Instead of answering our objections directly and fully, Mr. Gannett's letter attributes to us some exaggerated and imaginary statements and opinions, which he proceeds to demolish with evident relish and success. To make this apparent we desire to bring to the light some of these "men of straw" which are so valiantly overthrown, and afterwards to correct some of the assumptions and historical references which he makes.

1. Mr. Gannett avers that we objected to the extension of the field work of the Geological Survey over the entire United States. We did not mean to say that, and we do not think we did.

2. Mr. Gannett attributes to us a "misconception" of the significance of the term "national domain" used in the original law of the survey, and states that to avoid "such misconceptions" the efforts were made which finally resulted successfully in substituting United States for "national domain." We did not intend to express any opinion on the significance of the original term, and we do not think we did.

3. Mr. Gannett states that our editorial advocates the making of the geological map of the United States "without a topograph-

ical base." It seems to us that Mr. Gannett will search in vain for any such views in our editorial. We said (p. 310): "The Geological survey should follow the mensuration survey—so far as its mapping is concerned." We admit that we remarked that many *correct* geological maps have been constructed without previous topographical mapping. That was to show that the simple geological maps contemplated by the organic law of the survey, for the illustration of the "mineral resources and the classification of the lands" could be constructed correctly without elaborate topographical surveying.

4. The letter of Mr. Gannett aims to impair our argumentation on this subject and our good sense, which might otherwise be brought to bear on it, by assuming that we are not "practical geologists," and that therefore we are pardonable in not knowing what practical geologists need in the construction of geological maps. That is a "man of straw" which is so frail that it can hardly stand alone. The writer of that editorial has seen many years of practical geological work, and has constructed numerous geological maps, and he ought to be as competent to speak on the needs of geological mapping as any topographer, however expert in geodetic measurements.

5. Again, here is Mr. Gannett's statement: "The writer fortifies his statement by the assertion that up to the time the United States Geological Survey commenced systematic topographic surveys (1882) no geological survey had found it necessary to do topographic work." Now look on this, which is our actual statement: "We know of no precedent for it; but so far as example goes its influence would be opposed to it. The topographical mapping done by the early territorial surveys was discontinued by act of Congress, and no state survey had at that time entered upon topographical mapping under a law ordering simply a geological survey." The difference is so broad that any topographer ought to be able to discover it.

6. "His argument is that the higher the price the better the quality." We made no such argument, but it is a good principle that, *cæteris paribus*, the price is a good gauge for measuring the quality.

7. Mr. Gannett imputes to us "an attack" upon what is "presumably a useful work," implying thereby that we are opposed to the continuance of the topographical survey. We in-

tended to express no opposition to the prosecution of topographical mapping, and we do not think we did. On the contrary we argued that a better topographical survey should be conducted, and that it should be carried on by the Coast and Geodetic Survey.

Now we wish, *secondly*, to show that perhaps Mr. Gannett's acquaintance with some of the relations of his own work to the Coast and Geodetic Survey and to some historical facts of Congressional investigation, is "lamentably at fault."

1. Mr. Gannett states that the change in the appropriation bill from "national domain" to *United States*, was made to relieve the law of ambiguity, and that the law was interpreted by Mr. King, at the outset, as including the whole area of the country. Whatever may have been Mr. King's view of the law it is plain that it was not shared by his successor and that he (Powell) did not feel authorized to engage in surveying in the eastern portion of the country until the change was effected. The same view was held by Prof. J. D. Dana* and by the entire corps of the Coast and Geodetic Survey.†

The movement to transfer the activities of the Geological Survey to the eastern states, by making this simple change in the law, was antagonized by the officers of the Coast and Geodetic Survey, and by others, and was defeated on several occasions, and Maj. Powell says that the survey was not transferred till so authorized (in 1882), but that the meaning of "national domain" was understood to be *public domain*. (p. 3.) The existence of the law with the original phraseology effected a complete estoppel from work in the eastern, or older, portion of the United States. This is not only admitted by Maj. Powell, but, as already stated, was so understood by both parties to the controversy. There was therefore no ambiguity as to the effect of the term, whatever there may have been as to its significance. There was evidently no doubt about the intent of the original law, and there is as little doubt, in the minds of those who were affected by the change, that the intent of the change was not so much to remove ambiguity as to enlarge the scope of the survey.

2. The change was made "after full discussion in Congress." If this statement had been, *after a discussion in the committee of*

* American Journal of Science, (3), XVIII, p. 492, 1879.

† Testimony before the joint commission, etc., p. 167. Testimony of Maj. Powell.

the House, it might have been nearer the truth. Senator Hale testified that he was familiar with the debates, and "certainly it did not occur to members of the Senate, it did not so carry the idea, that this was to take upon itself the province of a survey of the old states. Now, in framing that language why did you not put it in fairly, and in terms?" (p. 18.) That does not indicate "a full discussion in Congress."

3. Was there any authorized agent for doing topographical work prior to the date when the Geological Survey entered upon it? And was such work actually being carried on? And was it being done systematically? Was there any co-operation by such authorized agent with the various States in the prosecution of such survey? To all these questions Mr. Gannett answers, No. But we undertake to say that the *Coast and Geodetic Survey was working, at that very time, under a far-reaching scheme which had been in operation for several years, under authority of law, on a general map of the United States of a character nearly identical with that now being executed by the United States Geological Survey.*

It is only necessary to read attentively the testimony given before the "Joint Comission to consider the organization of various scientific bureaus," 1884–1886, to become convinced of the adroit, masked interference, which the Geological Survey effected, through the sagacious testimony and opinions of its director, upon the organization and functions of the Coast and Geodetic Survey. In order to make this evident, a few quotations are made from the testimony.

Page 167. Maj. Powell distinctly states that the Coast and Geodetic Survey at first (1879-82) antagonized the proposition to transfer the Geological Survey to the eastern states—plainly because it considered itself as already performing, or in a way to perform, under existing law, the topographical work of that section so far as wanted. It was after the proposal to make this transfer that the rumors of duplication and interference arose.

P. *4. The report of the committee of the National Academy of Science states:

It appears therefore that two distinct and independent trigonometric surveys of the United States, under two departments of the Government, are now in process of execution.

P. 20. Maj. Powell states:

"The Coast Survey was authorized to do certain work for States. An appropriation was made for that purpose."

It is well known that Congress authorized the Coast and Geodetic Survey, and made special appropriations for the purpose, to aid such States as had inaugurated either geological or topographical surveys. Up to 1882 the following States had been aided in this way, viz.: Ohio, Indiana, Wisconsin, New Hampshire, Pennsylvania, Missouri, Kentucky, New Jersey, Connecticut, South Carolina, North Carolina, Tennessee, New York and Vermont, and more or less progress had been made in all of these States. Since then the number has been increased.

Prof. Hilgard says, p. 132:

"Under the provisions of the last clause aiding States having topographical or geological surveys, eleven States have inaugurated surveys which are now in active prosecution under direction of the Coast and Geodetic Survey."

The specific work done was the furnishing of a series of trigonometric points connected with the grand sytsem or "gridiron" of triangulation extended over the country, by which accurate topographical and all cadastral maps could be constructed as fast as wanted. In some instances the Coast Survey had made preliminary topographical maps (p. 41) like those of the United States Geological Survey, but the officers did not consider them final. Such maps were made in North Carolina, and they were used as a basis for the geological map of that state published by Prof. Kerr. Such were made in the region between Washington and South Mountain, (p. 42), and "in the interior", *i. e.* in Maryland and Virginia, where twenty-two finished sheets had been executed. Indeed there was an underlying expectation that there would result finally from the Coast and Geodetic Survey a complete topographical map of the United States. There was hence a perfect system of national and state topographical surveys well organized and under its charge, progressing as fast as necessary, with ability to progress indefinitely faster.

This was recognized by the National Academy of Science in its recommendations of 1878, and the organization of the United States Geological Survey was effected in 1879 without taking this function away from the Geodetic Survey. Indeed the action of Congress left the Geodetic Survey with all this duty on hand and in course of fulfillment, *and did not give it to the new survey*,

whose duties were, however, fully defined in its organic law. It was an after-thought that caused the Geological Survey to enter upon topographical work—and more especially so in the eastern states.

P. 238. Prof. George Davidson testified that the work of the Coast and Geodetic Survey is now (1884), "the very work which is suitable for the topographical map, or for geological purposes," though more accurate than that done by the United States Geological Survey.

P. 367. Prof. Hilgard states.

> By a proper co-ordination of plans the work for any part of the country, or for the Geological Survey, may be executed in conformity with the general plan.

The foregoing is sufficient to show that the Coast and Geodetic Survey was engaged (in 1882) in systematic triangulation of the older states with a view to a complete topographical map of the United States, and had executed a por tion of such topographical map in Maryland and Virginia, and was linked, under a law of Congress, with eleven of the States in preliminary work for topographical maps of those states, and had a reasonable expectation of continuance in that work to its completion.

4. It will next be necessary to consider another of Mr. Gannett's views as to the relation of his work to the Coast and Geodetic Survey. We stated in our editorial in the November GEOLOGIST that there came to be rumors of clashing of official functions, and of duplication of work, resulting in the appointment of a joint commission from the Senate and the House of Representatives, to consider the organization of these and other bureaus. Mr. Gannett says, "this statement is entirely without foundation." It is only necessary to refer Mr. Gannett and the reader to the following statements. We take first the statement of Mr. Theodore Lyman in notifying the National Academy of Science of their appointment and asking its aid.

> These important branches of our Government have grown rapidly and have reached a position where they in some respects impinge one on another in such a way as to threaten in certain cases, a duplication of work, and perhaps some waste and confusion. p. *2.

The committee of the National Academy of Science themselves state:

> The work of these four organizations should be more thoroughly coordinated than it is now. p. *2.

Again Mr. Lyman, an intelligent member of the committee, from Massachusetts, after the progress of the investigation had brought out prominently the respective duties and plans of the two surveys, remarks (p. 72):

Now, if we turn to the Geological Survey, that branch of the Government should be doing one thing and is doing two things. It should, after the manner of the English geological survey, which was started in 1832 under De la Beche, be simply engaged with geology, paleontology, mineralogy and metals, woods and forests if you please, and the like. But what it is doing outside of this is to make a map of this country, and on a basis which is not entirely satisfactory. That is to say, that map is not entirely based on accurate triangulations of the Coast Survey. Therefore, how are we coming out if we go on in the present way? In the first place, we shall have the work of the Coast Survey, as executed by the naval officers and the civil engineers, of the utmost accuracy, and, secondly, we shall have triangulations across the continent executed by that same reliable survey, to endure for all time. We shall have the admirable work of the United States engineers on the rivers and lakes; then we shall have the shiftless and slovenly work of the Land Office in plotting and parceling lands, and finally we shall have the Geological Survey as it is now going on, which is only "sufficiently correct": the head of that survey used that term before this committee. He said it would be sufficiently correct, which means not mathematically correct. Now it does not seem to me that for a nation which in a few years is to be the richest, the most powerful, and in certain respects the most civilized nation of the world: it does not seem to me that it is proper for that nation to go on in such a way. These labors should be co-ordinated and should be lifted to the highest plane possible.

That, I understand, is the object of the general plan proposed by the National Academy.

Prof. Hilgard stated (p. 54) that appropriation bills passed by Congress have ordered him to make a map of the United States—"compiling data for a general map of the United States" —and he exhibited one of the sheets thus made. When asked, "What relation is there between your map and Gen. Powell's geological map," he replied: "They are much too nearly alike to carry out both."

"You think that if this was completed his would not be needed?"

"No, I think that if his was completed mine would not be needed."

Is that clashing? Is that infringement? Is that interference?

There were eleven States co-operating with the Coast and Geodetic Survey in the construction of topographical maps in 1884. If there are none in 1892, as stated by Mr. Gannett, what is the probable reason?

P. 240. Prof. George Davidson testifies that to avoid duplication and lack of co-ordination which exists "according to a conviction which has grown up in his mind," there should be some authority, and the same authority, to control these two chiefs, and argues (on p. 241) against a "conflict" which he sees between the two surveys.

Enough has been said to show, it seems to us, that we were justified in our remark that there were rumors of clashing and duplication. We might have stated, without fear of successful contradiction, that *there was clashing*, and we might have adduced instances, but we did not presume that anyone would question such palpable historical facts.

5. We do not wish to go into details to show the deficiencies of the topographical maps of the U. S. Geological Survey. We are quite willing to admit that they are useful and good maps, and that we should be sorry to see the topographical work cease. We might, however, instance important tests of those maps by some of the first authorities in the country, and we could point to several of the States of the Union which have objected to them and have either insisted on better maps or have refused to make use of them in their own surveys. They serve, nevertheless, many useful purposes. Our chief objection is against the agency that is carrying on the work. We think it should be done by a distinctly mensuration survey, preferably the Coast and Geodetic Survey, and that the expense of it should not be burdened upon a "geological survey." It would be better to establish an entirely separate bureau charged with the execution of this map than to allow it to proceed under the present organization. That would give it definiteness and recognized standing in the appropriation bills, and it would leave the Geological Survey to prosecute its legitimate work in a definite sphere which also would have a recognized position and standing.

We do not wish to be misunderstood. We are opposed simply to the execution of this work under the name of a *geological survey*; as a *topographical survey* its work is not sufficiently exact for the demands of the closing years of the nineteenth century.

We have often wondered at the vast amount of work accomplished by the director of the United States Geological Survey, and have admired his ability and consummate tact in the management of the many interests intrusted to him. We do not wish to throw a straw in his way, but rather to relieve him of a portion of his labor, and at the same time to establish two of the great enterprises which he has in hand on sure and recognized bases. In that we aim as much to individualize and strengthen the geological survey as to correct and fortify the topographical survey.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

The Volcanic Rocks of South Mountain in Pennsylvania and Maryland. By GEORGE H. WILLIAMS: Amer. Jour. Sci., vol. xliv, pp. 482-496, Dec., 1892. The object of this article is to announce the identification of a large area of volcanic rocks which make up an important portion of South mountain. These rocks show abundant evidence of their volcanic origin in their structure, chemical composition and petrography. South mountain has been studied and described in more or less detail by Henry Rogers, Tyson, Frazer, Hunt and Lesley; but none of these geologists seem to have completely recognized the true nature and genesis of these rocks. They have hitherto been known as felsyte, argillyte, petrosilex, chlorite-slate, epidote-slate, etc., and their origin has usually been ascribed to sedimentary agencies. The reasons for the latter fact are that the jointing and slaty structure of the rocks, although of secondary origin, has been taken as proof of sedimentation, and that no one familiar with recent volcanics has examined them.

The igneous rocks of South mountain occupy an area of about 175 square miles and, so far as examined, are found to be of two classes—acid and basic, with their associated pyroclastics. The acid ones are usually porphyritic and are found to exhibit the characteristics of recent glassy and half-glassy rocks—such as flow-structure, perlitic structure, lithophysæ, spherulites, axiolites, etc.—in hardly less perfection than those described by Iddings from the Yellowstone park. A characteristic feature of the rocks under consideration is the eutaxic structure, i. e., the intermingling of two portions of the magma which show differences in color and chemical composition; when these mingle in interlacing bands there is some resemblance to sedi-

mentary banding. The acid rocks are found to belong to the group of *rhyolites*. The basic rocks, which prove to be *basalts*, occupy an area only about half as large as the acid ones. The former have been more generally sheared into slates and more altered than the latter, but sufficient of the original structure is left to show their volcanic origin, and in chemical composition they agree with normal basalts. Another proof of their igneous origin is that in places these rocks occur as dykes.

The age of the South mountain volcanics and their relation to the sandstone, in which Walcott has recently identified a lower Cambrian fauna, are briefly discussed and it is stated that the entire absence of sandstone inclusions in the lava and breccia, the observations of Keith, Geiger and Walcott, and the sections made by Miss Bascom across Monterey peak, Pine mountain, Jack mountain and Haycock all indicate that the sandstone is altogether above the volcanics. "The South mountain volcanic rocks therefore become, not merely in their petrographical character and richness in metallic copper, but also in their stratigraphical position, comparable with the Keewenawan or Nipigon series of lake Superior."

Extensive chemical changes, involving devitrification and the formation of new minerals, have gone on in the volcanics of South mountain, but their original structures are finely preserved. The formation of epidote has taken place to a great extent in the basalts.

It seems possible, and indeed very probable, that many more areas of old volcanic rocks will be recognized in other regions of America, when they come to be carefully studied. The rocks of South mountain have been known for many years and yet their true character was not discovered, and it is not going too far to suppose that many other rocks of similar characters have been overlooked and will in the future be given their proper position. In this paper Prof. Williams has not only given us some very interesting facts, but has also thrown considerable more light on the history of our earlier formations.

A contribution to the Geology of the Great Plains. By ROBERT HAY Bulletin, G. S. A., vol. III, pp. 519-521, with a general section on the 102d meridian. Two noteworthy features in the topography of the mid-Plains region are here noted. A valley lies between the margin of the plains and the Rocky mountains, the former having a steep western escarpment from near Pueblo to near Cheyenne, while westward from Cheyenne a ridge, constituting the highest part of the plains, runs up to nearly 7,000 feet and abuts on the tilted Mesozoic and Palæozoic formations of the mountains. The other feature specially described consists in the deep and very irregular erosion of the valleys in Nebraska and Kansas, between the Platte and the Arkansas, where sandy Tertiary beds are "carved into fantastic forms of castles and buttes and palisades which vary by a local picturesqueness the intense monotony of the plains."

On the structure and age of the Stockbridge limestone in the Vermont valley. By T. NELSON DALE. Bulletin, G. S. A., vol. III, pp. 514-519, with a map plate and two figures in the text. The entire thickness of the Stockbridge limestone in Rutland county, Vt., appears to be about 1,200 feet, of which the lower part, measuring about 470 feet, is of Cambrian age, as known by a *Hyolithes* bed at West Clarendon. The upper part of this limestone, however, according to its fossils collected by Rev. Augustus Wing and Mr. A. F. Foerste, is of Lower Silurian age, to which also belongs a part, if not all, of the overlying mass of Schist.

Supposed interglacial shell-beds in Shropshire, England. By G. FREDERICK WRIGHT. Bulletin, G. S. A., vol. III, pp. 505-508. A shell-bed discovered by Mr. Prentiss Baldwin and the author at Ketley, near Wellington, in Shropshire, containing many specimens of *Turritella communis* and a few other species, had a thickness of two or three inches, underlain by sand and gravel 25 or 30 feet thick and overlain by 10 to 15 feet of till. These marine shells, occurring about 500 feet above the sea, are ascribed, like those found up to about 1,100 feet at Macclesfield and 1,400 feet on Moel Tryfaen, to erosion from the bed of the Irish sea and transportation to their present position by an ice-sheet flowing southward from the Scottish highlands and from Ireland. As shown by Prof. Percy F. Kendall, the distribution of Scottish boulders is co-extensive with the occurrence of these marine shells and shell fragments. Such interpretation, according to Wright and Kendall, removes the principal ground for the supposition of an interglacial epoch in England. The lower and upper till are regarded as "probably the product not of two distinct glacial periods, but of minor episodes in a single period."

Geology of the Pribilof islands. By JOSEPH STANLEY-BROWN. Bulletin G. S. A., vol. III, pp. 496-500. The Pribilof or Seal islands, consisting of basaltic outflows and tuff, rise from the almost level submarine plain which is covered by the shallow waters of Bering sea. St. Paul island, the largest member of the group, has a length of 12 miles and width of 6 to 8 miles. Its shores are low, and its surface is diversified by numerous small volcanic cones irregularly grouped about the central crater, called Bogoslof, which is about 600 feet high. In a cliff of tuff on this island, known as Black bluff, which has been partly eroded by the sea, rounded calcareous clay fragments, containing fossil shells, are found; and each of the fifteen species collected here by the author and identified by Dr. William H. Dall, has living representatives in Bering sea. These fossiliferous fragments are explained by their being "caught up mechanically from the adjacent sea bottom and distributed through the cone during its creation."

St. George island, lying about 36 miles southeast of St. Paul, is slightly smaller. It differs from St. Paul in being a mesa, 300 to 1,000 feet high, bordered by a precipitous shore line. Its later lava flows issued from a vent near the middle of the island and from another on its northern shore, now more than half eaten away by the sea.

The Gulf of Mexico as a measure of Isostasy. By W J McGEE. Bulletin, G. S. A., vol. III, pp. 501-503. Subsidence of different portions of the shores of the gulf of Mexico appears to be closely proportionate to the local rates of deposition. It is thus indicated that throughout the southeastern part of North America isostasy is probably perfect, or, in other words, "that land and sea bottom are here in a state of hydrostatic equilibrium so delicately adjusted that any transfer of load produces a precisely equivalent deformation."

This paper is published in the American Journal of Science for September, 1892.

The Iroquois shore north of the Adirondacks. By J. W. SPENCER. Bulletin, G. S. A., vol. III, pp. 488-491. Plains and terraces of gravel and sand, occurring on the rivers flowing northward from tha Adirondacks, mostly between 700 and 1,200 feet above the sea, are regarded as evidence of the extension of the Iroquois shore to a distance of 100 miles northeastward from Watertown. Though this shore is continuous from Watertown southward to Rome, 440 feet above the sea, at the present divide between lake Ontario and the Mohawk, Prof. Spencer believes that the Iroquois water body was an arm of the sea, and that this region has been differentially uplifted since the Ice age to a maximium amount of about 1,200 feet.

Channels over divides not evidence per se *of glacial lakes.* By J. W. SPENCER. Bulletin, G. S. A., vol. III, pp. 491, 492. On the western side of the Adirondack *massif*, the divide between the head of the valley of the Black river and that of an eastern branch of the Mohawk is 1,141 feet above the sea. Terraces of sand and gravel lie at a considerable hight above the streams both north and south of this divide, the highest on the north, near Boonville, being at 1,190 feet, and the highest ten miles south of the divide being at 1,095 feet, which is 325 feet above the adjacent stream in the bottom of the valley. These terraces are regarded by the author as the former shores of a marine strait during the subsidence with which the Glacial period ended.

In the discussion of these papers, Mr. G. K. GILBERT, who had examined these areas with Prof. Spencer, attributed the plains and terraces to river action attendant on the recession of the ice-sheet, but could not regard them as shore lines either of lakes or of the sea.

Notes on the Geology of the Yukon basin. By C. WILLARD HAYES. Bulletin, G. S. A., vol. III, pp. 495, 496. This is a very concise abstract of the author's observations in the summer of 1891, during a journey of about 1,000 miles through the country east and north of Mt. St. Elias. The interior range of the St. Elias mountains, extending northwestward toward Mt. Wrangell, is found to have a simple synclinal structure and is composed chiefly of Carboniferous and Triassic strata. The white volcanic tuff which has been noted by various travelers on the Lewes and Pelly rivers was found to increase gradually toward

the west, reaching a maximum of about 50 to 75 feet in thickness in the upper White river valley, from that point decreasing very rapidly westward. The probable source of the tuff is a high conical peak close west of the 141st meridian, in the northern border of the St. Elias mountains. Glacial drift in the White river basin reaches only about 40 miles north of the present glaciers.

The paper is published in full by the National Geographic Magazine, vol. IV, 1892, pp. 117-152, with three plates.

Relationship of the Glacial Lakes Warren, Algonquin, Iroquois, and Hudson-Champlain. By WARREN UPHAM. Bulletin, G. S. A., vol. III, pp. 484-487. Lake Warren, held by the barrier of the retreating ice-sheet, extended from the western part of the basin of lake Ontario over the upper Laurentian lakes, and outflowed at Chicago to the Des Plaines, Illinois, and Mississippi rivers. When the recession of the ice uncovered the Mohawk valley, lake Warren became changed to lake Iroquois, the Glacial representative of lake Ontario, and to lake Algonquin, which occupied the basin of lake Huron, perhaps also extending into the basins of lakes Michigan and Superior, with outflow eastward at first through Balsam lake and the river Trent to lake Iroquois, and later by the way of lake Nipissing and the Mattawan river to the northward expansion of lake Iroquois in the lower part of the Ottawa basin. To this extent the Glacial history of the Laurentian lakes had been worked out by Spencer and Gilbert, beyond which Mr. Upham considers the question, Where was the ice-sheet latest a barrier across the St. Lawrence basin? The directions of glacial striæ and transportation of the drift show that the ice of that region during the closing stage of glaciation was thickest on a belt crossing the St. Lawrence in the vicinity of Quebec. Therefore it is inferred that lake Iroquois extended down this valley to Quebec, before the ice blockade was removed and the sea allowed to come in, when its marine fauna reached nearly to the present mouth of lake Ontario, to the south end of lake Champlain, and in the Ottawa valley to Allumette island, 75 miles above the city of Ottawa. A Glacial lake which had for a time occupied the valley of the Hudson and of lake Champlain was merged with lake Iroquois by the retreat of the ice from the northern side of the Adirondack mountains, the level of lake Iroquois being at the same time lowered about 250 feet.

Secondary Banding in Gneiss. By WM. H. HOBBS. Bulletin, G. S. A., vol. III, pp. 460-464, with a plate, and 4 figures in the text. Cleavage foliation, which has been mistaken for sedimentary stratification, is described in calcareous muscovite biotite gneiss near the Hopkins-Searles quarry in Great Barrington, Mass. Contorted quartz lenses and crumpled banding, approximately at right angles with the foliation, display the true bedding conformable with that of the dolomite in the quarry. Dr. Hobbs remarks: "The occurrence of parallel layers of different mineralogical composition in a metamorphic clastic rock has been considered one of the best criteria in determining the

planes of stratification, where these have been partially effaced by subsequently induced structures. The structures observed in the gneiss of the Hopkins-Searles quarry indicate that one may easily be deceived in applying this principle."

Similar observations by Mr. T. Nelson Dale (AM. GEOLOGIST for July, 1891) and Dr. J. E. Wolff show that the apparent strike and dip of the metamorphic strata forming large sections of the Green mountain belt belong to the superinduced cleavage, while traces of the sedimentary bedding are inconspicuous or altogether obliterated.

Proceedings of the Fourth Annual Meeting, held at Columbus, Ohio December 29, 30, and 31, 1891. HERMAN LE ROY FAIRCHILD, Secretary. Bulletin, Geological Society of America, vol. III, pp. i-xii and 453-541; Nov. 9, 1892.

The report of the committee on photographs shows 342 additions during 1891, all by donation, of which 25 are from the Geological Survey of Texas; 51 from that of the United States, including a series of 26 by I. C. Russell, taken during his second expedition to Mt. St. Elias and the Malaspina glacier; 31 from the Geological Survey of Canada; 63 of the Adirondack region, by S. R. Stoddard, of Glens Falls, N. Y.; 25 of mountain and canyon scenery in Colorado, by F. H. Chapin, of Hartford, Conn.; and 74 of the Muir glacier and its vicinity, by Prof. H. F. Reid, of Cleveland, O.

The accuracy of the printing of this volume, and its elaborate index, filling eleven pages with double columns in small type, reflect much credit upon Mr. W J McGee, the editor. Besides the memorial of Dr. John Francis Williams, which had been prepared for and presented in the GEOLOGIST for March, 1892, this brochure contains a number of papers, either entire or in abstract.

Elementary Geology. CHARLES BIRD, London. Longmans, Green & Co., 12 mo., pp. 248, 1890. This is a simple text-book for beginners, especially adapted to a class of boys who have a teacher to accompany them on excursions. Beginning with elementary definitions, the author gives numerous examples of dynamical geology and passes thence through the gamut of the formations from the Archean to the Pleistocene. It is intended for students resident in Great Britain.

North American Geology and Paleontology. S. A. MILLER. First appendix, extending the pagination to 718 and the illustrations to 1265. Mr. Miller has included new genera and species published since the appearance of the volume about two years ago. The increased volume is still sold at $5.00, by the author, Cincinnati, Ohio.

MR. GEORGE F. KUNZ has also issued an appendix to his work, *Gems and Precious Stones of America*, which extends his volume to page 367, including, with other additions, an account of diamonds found in Wisconsin and in meteorites.

A little more light on the United States Geological Survey. JULES MARCOU, Cambridge, Dec., 1892. In this Mr. Marcou continues his criticism of the methods and the officiary of the U. S. Survey.

Hand book of Physical Geology. A. J. JUKES-BROWNE, London. George Bell and Sons, 12 mo., pp. 666, 1892. Second Edition. This little volume cannot fail of being useful in the hands of all teachers and students of physical geology. It has little or no reference to historical geology. Its grouping and presentation of the dynamics of the surface of the earth, its accurate definitions and its condensed sketch of recent progress in the sciences of mountain-making, metamorphism and the substructure of the crust of the earth commend it to such as desire a compend in convenient form and from a reliable authority. The whole of physical geology is discussed under three divisions, viz.: dynamical, structural and physiographical geology.

CORRESPONDENCE.

THE HIGGINSVILLE SHEET OF THE MISSOURI SURVEY.—I notice in your issue for this month a review of our publication entitled the "Higginsville Sheet in Lafayette Co.," in which you raise certain objections to the form of publication, and offer certain suggestions concerning the publication of maps. As the subject is one in which I am very much interested, I wish to take this opportunity to reply to your objections and suggestions and to explain in some detail my reasons for adopting the form of publication represented by the Higginsville sheet.

It is my intention that the following remarks shall apply to a general system of mapping of a state or nation; not to special maps prepared for special purposes or of special districts. The accompanying reports referred to are brief descriptive reports of the area mapped, such as I have termed "Area Reports" (the equivalent of the county reports which have been used); large volumes or monographs treating of certain subjects, such as I have termed "Subject Reports," are not to be included under these remarks.

As I understand it, the questions at issue are:

1. What shall be the unit of area?
2. What shall be the size of sheet?
3. In what form shall the sheet be published?

So far as I can gather from your review, I conclude that your answers to these questions would be as follows:

1. The county shall be the unit of area.
2. The size of the sheet shall be uniform, but shall not exceed a large quarto page in dimensions: that is, the maximum size shall be about 9x12 inches.
3. The map shall be published as an insert in a quarto volume.

My answers to these questions, on the contrary, are as follows:

1. The unit of area shall be a geographic one and shall be a fraction of square degree of latitude and longitude.
2. The size shall be uniform and the sheet, including the margin, shall be $17\frac{1}{4} \times 21\frac{1}{4}$ inches.
3. The map shall be inserted without folding in a report of folio form of which the page of text shall be of the same size as the map.

My chief objections to the plan proposed by you are: that it restricts the use of a large scale and that it prevents the adoption of anything like a uniform scale. Further, a county is not a fixed unit, but is liable to be changed constantly by subdivision.

Counties are of extremely variable areas. Within the United States they range from 25 square miles to 12,000 square miles in extent; while counties of 200 square miles and 1,000 square miles in the same state are common. In Minnesota the smallest county is 162 square miles in extent, while the largest county contains 5,860 square miles. In Missouri counties range similarly from 270 to 1,145 square miles in area. The limits of a quarto page for maps of these areas would allow the scale, in some cases, to be as much as 2 inches to one mile; whereas, in another case, it would have to be as little as 1 inch to 11 miles. For counties in Missouri the largest scale permissible would be 1 inch to $1\frac{6}{10}$ miles and the smallest scale would be 1 inch to $3\frac{1}{2}$ miles. In Minnesota, similarly, small and large counties would have to be represented on scales varying between 1 inch = $1\frac{3}{10}$ miles and one inch = $7\frac{1}{2}$ miles.

It would be superfluous to argue before you the necessity of using a larger scale than the size you fix will permit, for the representation of all the valuable detail which we try to include in our modern geological maps. I take it for granted that you will recognize this without further demonstration, and it seems to me that this is an insuperable objection to the limitations of a quarto page. Granting this conclusion, the alternatives which suggest themselves for obviating the difficulty are as follows:

A To retain the county as the unit of area and to make the sheet of uniform size, but to enlarge the sheet to such a size that the largest counties can be represented in all the detail necessary.

B To retain the county as the unit of area but to abandon uniformity in the size of the sheets.

C To abandon the county as the unit of area but to retain uniformity in the size of sheet.

Adopting the first alternative (A), the county 1,000 square miles in area, mapped on a scale of one inch to the mile, would require a sheet at least 32 inches square; a county 5,000 square miles in area, mapped on the same scale, would require a sheet 72 inches square. A plan of publication necessitating such large sheets as this for small as well as large counties, is plainly out of the question.

According to the second alternative (B), a county of 160 square miles mapped on a scale of one mile to an inch, could be plotted on a

sheet 13 inches square; whereas a county of 5,000 square miles, mapped on the same scale, would require a sheet at least 72 inches square. Such a range in size of sheet as is here indicated—and a much greater range would at times be necessary,—is sufficient to condemn this second alternative.

The third alternative (C), is the one embodied in the Higginsville sheet. It retains uniformity in the size of the sheet; it permits the use of any scale desired; the size of the sheet is not too large for ready handling.

I recognize it as a controlling principle in the publication of a series of maps that, for comprehensiveness of view and in order that the relationship of parts shall be clearly seen, the area represented by the map should be as large as is possible, compatible with convenience for use. We are all familiar with the great and many times folded sheets accompanying many public reports; especially those of the earlier explorations in our country. Their large size and awkwardness defeat the main object. It is an exasperating problem to unfold them for reference without mutilation and it is a veritable Chinese puzzle to return them to their places with the same folds and creases.

The size represented by the Higginsville sheet seems to me a good compromise between these great maps and the small page plate. It is not too large for one to hold it in the hand or to have it at one's elbow on the desk convenient for reference; it is not so small as to prevent the representation of a large area on a reasonably large scale. The geographic unit of area is one of universal adaptability; it is absolutely fixed and its position on the surface of the globe is clearly defined to any man who has the rudiments of geographic knowledge.

Concerning the publication of the report in folio form along with the map I do not know that I can say anything further in explanation than has already been said in the "Notice" accompanying the report in question. The following is quoted from this notice.

"The controlling ideas have been to bring prominently forward, as an important part of the publication, the accompanying map and section sheet, and to make them of ready access for reference. The great amount of detail embodied in these sheets justifies the subordinating of the report to them. As future sheets and reports are issued they can be bound together in atlas form in substantial covers. Every one recognizes the objections to a folded map inserted in a pocket at the end of the report; it is inconvenient for reference; it is liable to become mutilated and torn from frequent folding and unfolding; it is often dropped out of the pocket and lost, and it can never, in its secluded retreat, be recognized as the prominent feature of the publication. An octavo report, accompanied by unfolded maps in a separate cover, is open to other objections perhaps equally strong; the chief of these are that the maps and reports are of different sizes and have to be separated in the library and are, hence, not readily accessible; one part frequently goes astray or is lost while the other, incomplete in itself, is retained; the two together are awkward to

carry. Inherent objections to the form of publication here advanced are, however, recognized. The report is of inconvenient size and shape for ready reading and it cannot be easily carried about for reference. Still, these objections, though inclining one to an adverse opinion on first thought, will, it is believed, appear of less weight when all the other considerations are taken into account; this has been the experience with most of those who have been consulted and who have considered the matter."

In reply to your objection that "common library shelves will not accommodate such a document," it seems to me that all collectors of books who make pretensions to having a library at all, must provide for the care of atlases and maps. Any broad shelf or drawer designed for this purpose will accommodate our publication.

In conclusion I wish to repeat that this subject of systematic mapping and the plan of publication is one which interests me very much and is one to which I have given a good deal of thought. No one is more anxious than am I to produce truly serviceable maps and to publish them in the best form, all interests considered. I am, therefore, glad to take this opportunity of expressing, in some fullness, my reasons and conclusions. I hope that they may elicit, similarly, free discussion from others; for it seems to me at the present time, when so much mapping is being done in various parts of the country and so much discussion on the subject is being entered into, it is particularly important that all the pros and cons be considered and that a well established conclusion be reached for guidance in future practice.

ARTHUR WINSLOW,
State Geologist.

Jefferson City, Nov. 14, 1892.

THE TOPOGRAPHICAL WORK OF THE NATIONAL GEOLOGICAL SURVEY. In the editorial in the December number entitled the "First Decad of the Geologist," you say: "The editors have had untrammelled freedom, as individual editors, to write whatever they chose. Sometimes they have found themselves at variance on views expressed, and they have had the privilege to write counter editorials in rebuttal of other views." In the November number of the GEOLOGIST was an editorial entitled "The Topographical Work of the United States Geological Survey," which was so entirely at variance with my views, that I beg you to insert the accompanying article by Mr. Henry Gannett, which expresses what in my opinion, is the exact status and value of that work. Whatever may be said concerning individuals upon the U. S. Survey, or the weakness alleged to exist in the other divisions, I believe the topographical map is by far the most important and useful work that could be accomplished for American geography and geology. There can be no more humiliating confession than that our country does not possess a map of its simplest geographic features, and aside from all geological considerations, I think that the topographical work should receive the loyal support and friendly aid of every American citizen. Furthermore, I believe that

major Powell and Mr. Gannett have conducted this division in the ablest manner possible, and it gives me much sorrow to see a journal bearing my name as an editor, opposing this great work. The present attitude of the government towards scientific bureaus is one that calls for the most delicate action and consideration, both upon the part of those in and out of the Geological Survey, unless it is their mutual object to destroy it. It is a pitiful spectacle to see the lack of united action in this emergency, and without committing myself to any faction, I can only say that accusations will not advance the best interests of science in this country, in the minds of our lawmakers.

Very sincerely yours, ROBT. T. HILL.

Washington, D. C., December 15, 1892.

THE TOPOGRAPHIC WORK OF THE NATIONAL GEOLOGICAL SURVEY. The November number of the AMERICAN GEOLOGIST contains an editorial criticizing the policy of the U. S. Geological Survey in carrying on topographic work and the quality of the resulting maps. This article contains numerous errors, some of which it seems worth while to correct.

The first item of policy of the geological survey to which this article objects is the alleged extension of its field of work over the entire United States. The geological survey was instituted in 1879, and its field of work was defined as the "national domain." This expression was recognized as being susceptible of several different constructions, such as

(1.) The public lands still owned by the United States.
(2.) The entire areas of the territories.
(3.) The entire area of all states and territories in which there was or had ever been public lands.
(4.) The entire area of the country.

Mr. King, the first director, adopted the last as the only reasonable construction, and immediately commenced examinations of the mines at Virginia City and Eureka in Nevada, and at Leadville in Colorado, all on private property and all located within states.

The attempts to obtain a change in the wording of the expression "national domain," to which the GEOLOGIST refers and the failure of these attempts, which it appears to regard as significant, were made simply for the purpose of relieving the expression of ambiguity, and to prevent just such misconceptions as those of the editorial from arising. The mistake of the GEOLOGIST is the less pardonable, inasmuch as the change proposed by director King was subsequently made after full discussion in Congress, in which all the bearings of the matter were examined.

The second and principal matter of criticism is the fact that the geological survey has undertaken the work of making a topographic map of the country and has for ten years devoted to it a considerable proportion of its appropriations. It does not appear that the writer criticizes the policy of the survey in undertaking a geological map.

That is the principal work of every geological survey the world over. He claims, however, that it can be done without a topographic base. Were the writer a practical geologist, such statements would necessarily impair confidence not only in his ability but in his good sense. It is an axiom that no good geological map can be made without a good topographic map as a basis. The U. S. Geological Survey found itself without such maps except in certain comparatively limited areas, and there being no provision under any other organization for making them, this survey undertook the task. It was a condition, not a theory, that confronted it. Perhaps the Coast and Geodetic Survey might have done the work better, but that organization was not doing it, and on application, declined to do it; therefore the geological survey having the means and having legal authority, proceeded to do it.

The writer fortifies his statement by the assertion that up to the time the U. S. Geological Survey commenced systematic topographic surveys (1882), no geological survey had found it necessary to do topographic work. Now the fact is, that with the exception of a few geological reconnoissances, every geological survey, whether under state or national authority, had prosecuted topographic work. Under national authority, the Hayden, Powell, Wheeler, and King surveys made topographic maps. Under state authority, the geological surveys of New Hampshire, New Jersey, Pennsylvania, North Carolina, Alabama, Kentucky, Ohio, Michigan, Wisconsin, Missouri, Minnesota and California had done the same, prior to 1882, while since that date many more have been added to the list.

In ten years the Geological Survey has surveyed topographically an area of 550,000 square miles at a total expense of $2,150,000. The average cost per square mile has been a trifle less than $4.00. The GEOLOGIST objects to this figure as being too low for good work—his argument is that the higher the price, the better the quality. But the area mapped includes regions surveyed on various scales, chiefly 1:250,000, 1:125,000 and 1:62,500, which implies a wide range in cost. It includes areas where the work has been greatly aided by the surveys of the General Land Office, the Coast and Geodetic Survey, the Lake Survey, the River Surveys, etc., all of which have been utilized and the average cost has thus been greatly reduced. The maps of the New England states on the scale 1:62,500 have cost per square mile from $9.00 to $13.00. This cost should imply to the GEOLOGIST good work, since it sets a limit of $10.00 per square mile as being satisfactory in the matter of expense. But work on the same scale in the Mississippi valley in Illinois, Iowa and Wisconsin has cost only $2.00 or $3.00 per square mile, and the results are quite as satisfactory as in Massachusetts and New York where the cost was four or five times as great. The difference in cost is due in the main to the assistance rendered by the surveys of the General Land Office whose corners furnish practically all the secondary locations.

In the third place, the GEOLOGIST charges duplication and clashing

between the Geological Survey and the Coast and Geodetic Survey. So far as known to one in a position to speak with authority, this statement is entirely without foundation. The Coast and Geodetic Survey is not mapping in the interior. There has been no duplication whatever, and instead of clashing there has existed the best of feeling and a most cordial coöperation between the two organizations. The Coast and Geodetic Survey has given in the fullest and freest possible manner all material desired by the Geological Survey, and its work has been utilized to the fullest possible extent by the Geological Survey in the preparation of maps.

Again, the article states that some fifteen or twenty States are now coöperating with the Coast and Geodetic Survey in the production of topographic maps. The fact is that no State is coöperating with that organization, for that or any other purpose. In certain states, namely, Tennessee, Wisconsin and Minnesota, the Coast and Geodetic Survey is executing triangulation at the request of the State authorities but at its own expense. In none of these cases is the State doing any topographic work.

The article contains numerous reflections upon the quality of the maps made by the Geological Survey. Now while the work must stand or fall upon its own merits, it is but just to the men who have executed it to remind the GEOLOGIST that errors will be found not only in the most expensive, but even in the very best work; and that in seven hundred sheets, representing 550,000 square miles, it would be strange if the errors, collectively, were not numerous. That the work, as a whole, is of good quality is sufficiently attested by those who have used it. Among them may be mentioned prominently the commissioners of the three States with which the Geological Survey has worked in coöperation, namely, Massachusetts, Rhode Island and Connecticut. The maps of these states have been completed, and the results after careful examination have been pronounced satisfactory by the Boards of Commissioners. That the surveys are satisfactory to engineers is abundantly shown by the extensive use made of them by state geological surveys and by mining engineers, as well as in railroad location and other similar works. For these purposes hundreds of proof sheets are daily distributed. They are in the hands of geologists and engineers all over the country and are in very extensive use.

In the mapping of its area this country is far behind other civilized nations. Scientific and industrial enterprises in this country have always been handicapped by the need of them. The Geological Survey is now engaged in supplying this need upon a practicable plan, and at reasonable expense, immediately for its own use, but quite as much for the use of the public. It would appear that an attack upon what is presumably so useful a work should be undertaken only with a full knowledge of the circumstances and the technical details of the work, in both of which the writer of the article shows himself lamentably at fault.

HENRY GANNETT.

Washington, D. C.

PERSONAL AND SCIENTIFIC NEWS.

THE MICHIGAN GEOLOGICAL SURVEY.—After a comatose state for ten years, the "Board of Geological Survey" of Michigan has presented a report to the Legislature. Dr. M. E. Wadsworth, Director of the Michigan Mining School at Houghton, is state geologist and has the assistance of various members of his faculty. The report is a provisional one on the iron, gold, and copper districts of northern Michigan. In addition to this there is nearly ready for publication, Vol. 5, in the series of final reports, containing the geology of the Marquette district, the report of Dr. C. Rominger, and that on the gas and salt wells of the state.

ACCORDING TO MAJOR-GENERAL DRAYSON, of the Royal Artillery, the earth has a *third rotation*, which causes the half-axes of daily rotation to trace cones during a period of about 31,600 years. He concludes that the glacial periods depend upon this third motion, and that they recur once in about 20,000 years, whilst the last terminated about 6,000 years ago. The extreme variation of the poles amounts to about 12 degrees. The arctic circle encroaches on the temperate latitudes, and the tropic of Cancer varies the same amount toward the poles. The positions of these extremes determine the differences between summer and winter. General Drayson supposes a glacial epoch supervenes when the difference is at maximum, coincident with the pole of the heavens and the pole of the ecliptic in the same colure; and that the minimum of this difference, which marks the mild (or interglacial) epochs, will be reached in about the year 2295, A. D. The work, "*Untrodden ground in astronomy and geology*," discussing this theory is published by Chapman and Hall, and Paul, Trubner & Co., London.

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS. The program of the twenty-third meeting held December 29th and 30th, at Madison, contained the following geological titles:

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DR. J. S. NEWBERRY, who has been professor of geology and paleontology in Columbia College, New York City, for twenty-two years, died at New Haven, Conn., Dec. 7, 1892. A future number of the GEOLOGIST will contain a suitable biographical sketch.

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PERSONAL AND SCIENTIFIC NEWS.

THE MICHIGAN GEOLOGICAL SURVEY.—After a comatose state for ten years, the "Board of Geological Survey" of Michigan has presented a report to the Legislature. Dr. M. E. Wadsworth, Director of the Michigan Mining School at Houghton, is state geologist and has the assistance of various members of his faculty. The report is a provisional one on the iron, gold, and copper districts of northern Michigan. In addition to this there is nearly ready for publication, Vol. 5, in the series of final reports, containing the geology of the Marquette district, the report of Dr. C. Rominger, and that on the gas and salt wells of the state.

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to their junction with the Sierra Nevada, yet there seems to be no doubt that such is actually the fact, as was found to be the case with the northern Coast ranges.

In my former paper I traced the Palæozoic rocks of Shasta county, part Carboniferous and part probably Devonian, south along the main Coast range to San Francisco bay. The lithological features of the series were quite constant the whole distance, sandstone, slate and banded jasper predominating. The effects of intense dynamical action, resulting in crushed and contorted strata; and secondary silicification, in which these strata were filled with a net-work of minute quartz veins, were seen to be constant and distinguishing features. With the exception of fossils of probable Palæozoic age from western Tehama county, none were found in this older series; but the Knoxville, the lowest known Cretaceous in the state, wherever present, was found generally to contain Aucella, and to rest totally unaltered and unconformable on the Metamorphic series.

The bay of San Francisco is formed by a depression extending across the Coast ranges from the great interior valley to the ocean. The outlet to the bay, the Golden Gate, is bordered by sandstone and jasper containing dikes of serpentine and other greatly altered eruptives. As we go southward the ranges forming the Coast system become very regular in their northwest and southeast trend. They do not run quite parallel to the coast, but lap past each other, forming a succession of headlands. Between these are long narrow valleys opening northwestward.

The three most prominent ranges are the Monte Diablo, the Santa Cruz and its southern prolongation the Gavilan, and the Santa Lucia. They consist chiefly of granite, crystalline schists, and often but slightly altered sandstone, slate and jasper. As has been noted before, these rocks are so crushed that no system of folds can be made out, and the strike and dip are often almost indistinguishable. Greatly decomposed eruptives of many varieties are abundant. No granitic rocks have been found in the Monte Diablo range, but mica, hornblende and glaucophane schists appear in places. The first known outcrop of granite in the Coast ranges south of Trinity county, is on Tomales point, about twenty miles northwest of San Francisco. This outcrop lies in line with the granitic rocks of the Santa Cruz mountains, and is quite likely a continuation of them. South of San Fran-

cisco granite outcrops first near Pt. San Pedro, and appears at intervals, above the Tertiary which covers the western slope of the mountains, as far as Santa Cruz. Ten miles away in a southeast direction, in line with the former outcrops, rises the Gavilan range, called by Prof. Blake "a mighty mass of primitive rock." The range proper has a length of fifty miles and a width of ten. It is composed almost wholly of granitoid rock. Near the northern end are bodies of limestone and crystalline schists. Southeast of the Chelone peaks the range blends with the Monte Diablo range, and the granites are largely replaced by rocks of the Metamorphic series. These rocks form a long high ridge which sinks beneath the Tertiary before reaching Polonio pass. The granite of the Gavilan range does not terminate in the Chelone peaks, but outcrops in places along the western base of the Metamorphic ridge for a distance of forty miles more. Its width cannot be determined for it is covered by the Tertiary on the west.

In the canyon of Nelson creek the granite is seen to be brecciated, and to include broken strata of limestone. In a small gulch which enters the canon of Nelson creek from the high ridge of Metamorphic rocks on the northeast, there is exposed one of the most important contacts seen in the whole Coast range, and one which should settle the disputed question of the relation of the granites to the Metamorphic series. The gulch cuts squarely across the formation exposing the succession of strata very finely. Beginning at the mouth of the cañon we find outcropping first a fine grained granite so crushed that a hand specimen could not be obtained; next a stratum of limestone also brecciated and wholly inclosed in the granite. Following the granite, another irregular stratum of limestone. These dip to the southwest at an angle of 80 degrees, the granite overlying. They are followed by several hundred feet of mica schist, often presenting a pearly and hydrous appearance. Another stratum of limestone adjoins the schist, and that is succeeded by. a width of twenty feet of banded green jasper. Then there is a great body of semi-crystalline limestone thirty feet thick; above that, green jasper again; the whole series dipping 80 degrees southwest. Farther up the hill the jasper gives place to crushed sandstone and serpentine. It does not seem that there can be any doubt about the granite having been intruded into these rocks which are an in-

tegral portion of the Metamorphic series. This determines the relative ages of the two formations; and if it is a fact, as I believe it to be, that this granite is identical in age with that forming the great mass of the Sierra Nevada, the Metamorphic rocks into which it has been intruded belong to the same series and were uplifted at the same time as those of the Sierra. The time of this convulsion is supposed to have terminated the Jurassic, and to have been followed by the lowest undoubted Cretaceous rocks on the Pacific coast.

The Santa Lucia range which begins at point Pinos, Monterey county, and extends down the coast in a southeast direction, consists almost wholly for a distance of sixty miles of a coarse and somewhat porphyritic granite. Near the head of the Nacimento river, the main southerly prolongation of the range changes its character, the granite being replaced by rocks of the pre-Cretaceous series. This change is not abrupt, the massive rocks giving place to gneiss and schists, and these to metamorphosed slates, sandstones and jaspers. Owing to the extensive development of the Miocene sandstone on the eastern slope of the range the complete transition could not be seen. The granite does not terminate here but bears away from the ocean, and crops in several places in a line of low Tertiary hills which extends southeast between the Nacimento and San Antonio rivers. The third of these outcrops lies near the town of Paso Robles. In line with these exposures and about twelve miles in a southeast direction, granite appears again in the San Jose range. This range has an elevation of nearly three thousand feet and a length of thirty miles. No Metamorphic rocks appear, and near the head of Carisa creek the granite again sinks beneath the Tertiary. A high ridge of Tertiary hills connects the San Jose range with the San Emedio mountains, but as far as my observations have gone, the granitic rocks do not outcrop again until the latter mountains are reached. Blake, however, in the Pacific Railroad report maps the granite as almost continuous. Inasmuch as the several outcrops of this almost buried granite ridge lie directly in line with the course of the San Emedio range, and its prolongation both southeast and northwest, it seems highly probable that the two are really connected underneath the Tertiary.

The Santa Lucia range follows the coast until near the town of San Luis Obispo, when it in turn passes inland, becoming wholly

covered by the Tertiary in places. The rocks exhibit as usual the effects of intense dynamical action, but have not been greatly metamorphosed. They have been intruded by a great variety of ancient eruptives which are much decomposed. In Santa Barbara county the Santa Lucia range becomes merged in the Cuyama mountains, but the rocks are finely exposed in the canon of the Santa Maria river. In the central portion of the county they finally disappear beneath the Tertiary, which rises in mountains five to six thousand feet high. The most southerly outcrop of the peculiar Coast range metamorphics forms a line of hills along the western slope of the San Raphael mountains on the borders of the Santa Ynez valley. Here are jasper, sandstone and glaucophane schists. Here as well as in the Cuyama range the rocks have the same lithological character and have undergone the same crushing as the almost unbroken line of outcrops extending north to Shasta county. Secondary silicification is often present, but is not as characteristic as farther north. The overlying Tertiary sandstone, shale and banded flints, are folded but not metamorphosed or crushed. In southeastern Santa Barbara and northern Ventura counties the Tertiary beds have been enormously elevated, forming very rugged mountains five to eight thousand feet high.

As we go south of Monterey the pre-Cretaceous series gradually sinks, and the middle Tertiary becomes more and more prominently developed, until in the region just described, it forms the whole of the exposed portion of the mountains between the San Joaquin valley and the ocean.

The other prominent mountains of southern California included by Prof. Whitney in the Coast range system are the Santa Monica and the Santa Ana. The Santa Monica belongs to the east and west system of ranges, and has been classed by the earlier geologists who have studied it as Tertiary. The range was examined in a number of places with very different results. Miocene sandstones appear in the hills along Santa Monica canon for two miles when they are replaced by black slates. Both these formations dip south at a small angle but no contact could be found. Farther up the canon the slates are replaced by dark argillitic sandstones. They become more metamorphosed near the summit where there is incipient crystallization In Coldwater cañon the Metamorphic series appears for some distance, and is then replaced by dioritic

granite which has been intruded into it. South of the Encinos ranch on the northern slope of the Santa Monica range, is an interesting exposure of rocks. First there are Tertiary sandstones dipping north 25-40 degrees. Under these are the crushed and metamorphosed rocks of the older series, with stratification hardly discernible. Just above the sandstones the older rocks are intruded by dioritic granite. There is no sign of the granitic rocks having been intruded into the Miocene, and there seems not the slightest doubt but what the crystalline and metamorphic rocks represent an older pre-Cretaceous formation. I have been able to verify none of Prof. Whitney's statements in regard to Tertiary or even Cretaceous granite in California. He says of the Santa Monica range that granite forms the axis, and that it has been intruded into Miocene sandstones which are much metamorphosed and dip away on either hand.* The real Miocene has been confused with the underlying older series, and both classed together as rocks of the same period. Prof. Jules Marcou also held the opinion that no rocks older than the Tertiary existed in the Santa Monica range.† The mistake heretofore made is due to a confounding of the Tertiary with the underlying pre-Cretaceous series. In those portions of the report on the Pacific railroad survey, and of the general geology of California, Vol. I, devoted to the coast region, this mistake is constantly made.

The Santa Ana mountains are a spur of the Peninsula range of San Diego county. The sedimentary rocks are often but slightly metamorphosed, and fossils of probable Carboniferous age were found in three different places. One fossil bearing stratum was discovered within less than a mile of the granite of Santiago peak. It was very highly metamorphosed, being apparently a micaceous felsite. The other fossils were in a dark gray limestone only slightly altered. In portions of the range the quartzose rocks are filled with a network of small quartz veins very closely resembling the characteristic phenomena of the Coast ranges farther north. The fossil bearing rocks have been intruded by granite which forms an integral part of the Peninsula range.

A glance at a topographical map of California shows two main chains of mountains. One extending near the coast the whole length of the state; the other and more rugged one, branching off

*Geological Survey of Cal., Vol. I, p. 121.

†Geographical Surveys West of the 100 Meridian, 1876, p. 172.

from the Coast system in Shasta county, also extends parallel to the coast but at a distance of two hundred miles from it. In the course of six hundred miles this range gradually approaches the Coast system in the form of an immense arc, and finally unites with it in northern Ventura county. This union is so intimate at both ends that no one can say where the one terminates and the other begins. From northern California to the point where the ranges approach each other on the south, the compression, producing the folding and crushing and which gave rise to the mountain axes, acted in quite a uniform direction, northeast and southwest, forming the two approximately parallel systems. South of a line running east and west through the southern end of the San Joaquin valley, the compression has been from a different direction, that is from the north and south; producing an east and west system, of which the mountains in southern Santa Barbara, Ventura and Los Angeles counties, and the islands south of the Santa Barbara channel are examples. As another result of this north and south compression, the Sierra system was turned out of its normal course into one taking the form of the resultant of the two forces; consequently the nearer it approached the Coast system, the more it was deflected, assuming successively a south, southwest, west, and finally a northwest course; the actual exposed portion of the crystalline rocks terminating in the high peaks at the western end of the San Emedio range. The main mountain system extending from Frazer mountain south of the Mojave desert, including the Sierra Libre, the Sierra Madre or San Gabriel, and San Bernadino ranges, shows a union of the two forces, producing a fold having a direction a little south of east and north of west. Through San Diego county the normal southeast direction is shown in the regularity of the Peninsula range. The two forces acting simultaneously gave to southern California the irregular system of mountains which has been included by some in the Sierras and by others in the Coast system. The position assumed by the mountains formed by the union of the southern Sierras and the northwest prolongation of the Sierra Madre is very suggestive. They are inseparably connected with the Sierras, and yet seem an integral part of the Coast system. Thus we may conceive as having been formed at the same time with the final great upheaval of the Sierra system, and its accompanying granitic rocks and intense metamorphism, the Coast range

system, exhibiting fully as great metamorphism through the Peninsula, San Bernadino, and Sierra Madre ranges, but from the termination of the San Emedio range northwest through the coast region until Trinity county is reached a much less degree of metamorphism. In the coast region the sedimentary rocks are not crystalline save in the vicinity of the granite, which except in the main portion of the Santa Lucia, San Jose, and Gavilan ranges is not found in very large outcrops. This granite seems to have been squeezed up along axes of greatest disturbance and not to have exercised a pronounced regional metamorphism.

Although the sea had free access through eastern Santa Barbara county to the San Joaquin valley during Tertiary times, there is evidently no structural break, simply a depression. In this depression are thick beds of sands and clays, hiding the northwest prolongation of the San Emedio range. After passing over the space now occupied by a line of Tertiary hills, there appears another granite ridge, the San Jose mountains. Northward there are other outcrops slightly projecting above the almost universal Tertiary, until the high and rugged Santa Lucia range is reached. The other prominent crystalline axis in the Coast range north of Ventura county is the Gavilan. Dr. Becker, one of the strongest supporters of the theory that the metamorphic rocks of the Coast ranges are Cretaceous, has admitted that if there are any formations older than the Cretaceous in the Coast ranges, they are the limestone and gneissoid rocks of the Gavilan range.* It is the southern continuation of the granitoid rocks of this range by which the characteristic metamorphic series has been intruded. What can be admitted of the Gavilan range must also be true of similar rocks in the Santa Lucia.

As far as I can learn but two specimens of fossils have been found in the metamorphic rocks of the central Coast ranges. One was an Inoceramus, presented to the old state survey by major Elliot who found it on Alcatraz island, San Francisco bay. Prof. Whitney says: "But so crushed and broken are the strata thus revealed to view and so few and indistinct the fossils which they contain, that it was a long time before their real age could be clearly made out, and it was not until after we had decided on stratigraphical and lithological grounds that the so called 'San Francisco sandstone' must be of Cretaceous age that the timely discovery of a single

*Geol. of the Quicksilver Deposits, p. 128 and 181.

shell, undoubtedly of this epoch, in the rocks of Alcatraz island, gave the additional desirable assurance of the correctness of our views."* In another place he says of this fossil: "Presented to the survey by major George H. Elliot, U. S. Engineers, by whom the first specimens were discovered. On subsequently visiting this locality I found numerous casts of this and of several other bivalves, the latter in too imperfect a condition to be recognized. The species is of unusual interest, being the first incontestable proof of the Cretaceous age of the long disputed San Francisco sandstone."† A close examination of the island has recently been made, but no traces of any molluscan remains have been found. The sandstone of the island is identical with that of the mainland both north and south which I hold to be pre-Cretaceous.

The genus Inoceramus is not confined to the Cretaceous. J. S. Diller has recently found specimens of it in the Jurassic of Plumas county,‡ while in the Cretaceous of California I believe it is confined to the upper division, the Chico, not being known in the Shasta group. The specimen found on Alcatraz island was not in good condition, and I think it can safely be said that there is room for doubt concerning the correct determination of this fossil.

The other fossil which has been made use of to determine the Cretaceous age of the Coast ranges is a supposed Aucella from the Santa Lucia range, a little east of San Luis Obispo. It was found by Mr. Turner while gathering material for the report on the quicksilver deposits of the Pacific coast § In "Correlation Papers," Cretaceous, Dr. White speaks of the most southerly known locality of the Aucella as near parallel 37 degrees 30 minutes north latitude,‖ that is, in the Mariposa beds, thus ignoring the specimen from San Luis Obispo, which may have been determined wrongly. As European authorities in particular disagree as to the time range of the genus Aucella, whether it is characteristic of the Jurassic or Cretaceous, or of both, it does not seem to be the proper thing to classify a great series of rocks by it alone. There has existed much uncertainty with regard to the exact classificatien of the Aucella in California, and

*Geol. of Cal., Vol. I, p. 77.

†Palæontology of Cal., Vol. II.

‡Bull. Geological Soc. of America, Vol. III, p. 405.

§Geology of the Quicksilver Deposits, p. 381.

‖Bull. U. S. Geological Survey, No. 82.

many changes have been made. Jules Marcou has lately asserted that the older genus Avicula has been confused with the Aucella, and that the rocks in which it is found are not Cretaceous but much older.* I suppose he refers to the attempt to include in the Cretaceous the supposed Aucella bearing strata of the Mariposa beds which were classed by Gabb in the Jurassic. Granting that the classification is perfectly correct, Dr. White acknowledges that the Aucella is not unequivocal in its signification and says: "I do not think that any satisfactory evidence has yet been presented to show that the genus Aucella is exclusively confined to either the Jurassic or the Neocomian, and I know of no reason why we may not expect to find species of it in both Jurassic and Neocomian strata."† Again speaking of the Mariposa beds on the Merced river, says: "The strata have an almost vertical dip, and they are plainly an integral part of the great Auriferous Slate series."—"The great Auriferous Slate series is an immensely thick one, and in northern California it is known to include strata of Carboniferous age."‡

There can be no question but what the genus Aucella is one of the most characteristic lower Cretaceous fossils in California, and it is fully proved that these unaltered beds rest unconformable upon the Metamorphic or Auriferous series. Several examples of this were cited in my former paper. It has also been fully proved by Mr. Diller and others that there is no important nonconformity between the lower and upper California Cretaceous. Consequently the nonconformity shown where the Chico rests directly on the Auriferous series in the Sierra Nevada, may with certainty be referred to a pre-Cretaceous upheaval.

The interesting discoveries of J. S. Diller in the Taylorville region have an important bearing on the question under discussion. He found there the most complete series of Jurassic beds yet known in the United States, lower, middle and upper Jura being represented. With regard to the separation between the upper Jura and the Cretaceous Mr. Diller says: "So far as yet known, on the fortieth parallel the rocks next younger than the Taylorville Jurassic are the Knoxville beds of the earlier Cre-

*Geological Map of the United States.

†Bull. U. S. Geological Survey, No. 15, page 26.

‡Bull U. S. Geological Survey, No. 1, p. 25.

taceous.' They are widely separated in space, and it is probable that there was between their periods of deposition a considerable lapse of time, in which the rocks of the Sierras were greatly deformed by compression and raised above the sea; consequently the shore line of the Cretaceous sea scarcely reached the western base of the Sierra Nevada and laid down its deposits unconformably upon the older rocks."*

I believe this upheaval was the most far reaching and important one which can be recognized in the geology of the state. Consequently we have to accept one of two things, either the supposed Aucella in the metamorphic rocks and that in the unaltered Cretaceous are not identical, or the species is not characteristic of the Cretaceous and has survived the most intense convulsion known. In either case the evidence is uncertain and cannot set aside results founded on careful lithological and stratigraphical investigations.

We can say with certainty, that whatever the range of time represented by the older rocks of the Coast system, their earliest upheaval was pre-Cretaceous, their final great uplift dating from post-Miocene times. That the southern Coast ranges were covered by the sea during a part of Cretaceous and Tertiary time is no proof at all that the axes of these ranges did not exist ready formed and intruded by granite.

Accepting the view that the granitic axes of the Coast mountains are of the same age as the main body of the granite of the Sierra Nevada, the Sierra Madre, San Jacinto and Peninsula ranges, the intrusion occurred at the close of the Jurassic, producing the first foldings in the region now occupied by the extensive Coast system. The time of the appearance of this initial fold is that from which we must date the age of the Coast ranges. Blake says, in speaking of the age of the Coast Range system: "The age of an axial rock combines the idea of the first upheaval through the hardened crust, and to some extent the period of its appearance above water, though not necessarily the latter idea."† It does not seem to have occurred to Prof. Whitney or to the geologists of the Pacific Railroad survey, that the granitic axes of the ranges on which the Miocene, as a rule the lowest sedimentary deposit present, has been deposited,

*Bull. Geological Soc. of America, Vol. 3, p. 383.
†Pacific Railroad Survey, Vol. 7, p. 24.

must, if we accept the definition of granite as a deep seated rock, have been above water and have undergone very extensive erosion through a protracted interval in order to have removed the great thickness of sedimentary strata lying above it. The interval is represented by the whole of the Cretaceous and the lowest portion of the Tertiary. The Miocene Tertiary, wherever the granites are exposed, rests directly on them with no intervening formations. The Chico-Tejon series is present on the eastern slope of the mountains bordering the San Joaquin valley, showing plainly that the main portion of the system was above water during the time of the deposit of the beds of that series. Whether great or small, the elevation certainly existed, being structurally connected with the Sierra Nevada at both ends.

The following quotations are from the writings of the earlier investigators, and will serve to illustrate their views. Blake says: "The age of the granites of the Sierra Nevada and the Cordilleras in parallels 32–34 is anterior to the Eocene deposits and posterior to the later Palæozoic; the age of the Coast ranges is posterior to the Miocene."—"All the observed sedimentary rocks were of the post-Cretaceous period."* In another place it is stated, speaking of Los Angeles, Ventura and San Diego counties, in which the Miocene has been so greatly elevated: "The Cordilleras, therefore, have been raised since the deposit of the Miocene beds of California, and are thus coeval with the Coast ranges, with the Sierras, Santa Ynez, San Raphael, and San Jose; indeed, perhaps the latter are the true continuation of the chain towards the northwest. Both have the same direction, both have the same sedimentary beds flanking them, the nature of the axial rock is similar, and the volcanic rocks erupted on its sides are similar; and, lastly, both are connected by an intervening mass of mountain, the San Emedio region.—The sandstones described as peculiar to the eastern slope stretch in and occupy the angle formed by the termination of the Sierra Nevada at the Canada de las Uvas and the San Emilio mountain, which lies fifteen miles west;—the sandstones dip away from the granitoid rocks of the Cordilleras, and so on toward the Cajon pass, while they run directly up to and lie unconformably upon the Tejon granites. It would thus appear that this sandstone was deposited originally upon both ranges, the Nevada and the Cordil-

*Pacific Railroad Report, Vol. 7, pp. 24–25.

leras, but since the deposition the former was not raised, while the latter was Should this observation prove correct, it follows that the Cordilleras are of a later age than the Sierra Nevadas; a view which I think the correct one, though opposite to the one taken by Mr. Marcou. Nothing appears easier to trace than the relations of connection and continuity between the middle of the Coast ranges (San Jose and point Pinos) and San Emilio, and between San Emilio and the Cordilleras, a fact now for the first time stated and brought to light by the exploration of this survey, by which there has been traced a continuous granitic chain from point Pinos, at Monterey bay, to the northwestern edge of the Cajon pass, terminating at the Kikal Mungo mountain."* He speaks of the sandstone being deposited on both ranges and then that one range dates from the post-Miocene upheaval, evidently a contradiction.

Jules Marcou, the eminent French geologist, who spent some time in southern California as geologist of the Pacific railroad survey, and later with Wheeler's survey, sums up his opinion with regard to the mountains of a portion of southern California as follows:

I. "Sierra Madre, of the Primordial epoch, anterior to the Silurian.

II. Coast Range, of the close of the Eocene.

III. Sierras of San Fernando and Santa Monica, of the close of the Pliocene." He says farther that nearly all the ranges of southern California belong to the Primitive formation, and considers the Sierra Madre as simply a continuation of the Sierra Nevada.† His reasons for classifying the Coast ranges as Tertiary are the same as those of Prof. Blake.

Prof. Whitney in discussing the relation of the Sierras to the Coast ranges says: "As we skirt the base of the Sierra, however, in the region where this chain turns to the west, toward Fort Tejon, we pass at once from undisturbed Tertiary to strata of the same age which are elevated at a high angle, and, in so doing, we leave the system of the Sierra and pass over to that of the Coast ranges. This change takes place about midway between the Cajon pass and the Canada de las Uvas; *but no break in the mountain ranges indicates this transition.* The great lines

*Pacific Railroad Survey, Vol. 7, p. 90.

† Geographical Surveys. Wheeler, 1876, page 172.

of disturbance are so closely connected with each other in direction, and they have been so affected in this vicinity by the existence of secondary ones, that the topography of the country does not reveal the geological facts, which not the less do really exist.

"Starting from a point a little to the east of the Canada de las Uvas, and drawing a line which shall leave on the west all the mountains elevated since the deposition of the Cretaceous, and on the east those which have not been disturbed since that epoch, we find that, according to our present state of knowledge, this line will pass to the east of the San Gabriel range, through the Tejon pass, to the east of the Temescal range and on the south of the Santa Ana, striking the ocean in the vicinity of San Luis Ray, which is the most southerly point to which the Coast range system has been traced. The masses of San Bernadino and San Jacinto are included in the Sierra Nevada, which runs south and occupies the peninsula of lower California, the Coast range system not having an existence in that region." *

To Blake is due then the credit of having first announced the intimate relation existing between the Coast system and the Sierras, but it is evident that he is wrong in the conclusion reached with regard to the relative ages of the two.

In discussing Prof. Whitney's statements I wish to show how artificial is his line separating the two systems of ranges. In the first place the change from undisturbed to steeply inclined Tertiary beds near Fort Tejon, indicates simply the point to which the effects of an important uplift of the Coast ranges in post Miocene times extended. This uplift was not felt to any extent in the Sierra Nevadas, and the fact remains as indisputable that the granites and crystalline schists of the Sierras extend unbroken through the Tehachapai and San Emidio ranges. The granites and schists of the San Gabriel range also extend unbroken through the Cajon pass to the San Bernadino range, and this is separated from the San Jacinto by the San Gorgonio pass, which I believe represent no structural separation. The granites and metamorphic rocks of the Santa Ana mountains I have also demonstrated to be continuous with those of the Peninsula range.

It seems to me that the geologists who have studied this sec-

* Geology of Cal., Vol. I, page 167.

tion have failed to note the structural relations existing. The complicated topography does not indicate such difficult geological problems. Two forces acting at an angle with each other in this region are amply sufficient to account for the irregularity exhibited.

Very interesting questions remain to be solved with regard to the granitic rocks of southern California. Do they all date from the pre-Cretaceous upheaval or are there older formations? The presence of Archæan granite in the canon of the Colorado is amply proved, but the relation of the crystalline rocks of eastern California to this primitive formation is not known. It may be well to emphasize the fact that the granitic rocks of the Santa Ana range, which are inseparable geologically from the whole Peninsula range, do not underlie the Carboniferous limestone and shales, nor have they been brought to light by simple uplifting or faulting, in which case they would be older, but are present solely as far as my observations have gone, as intrusions squeezed into the sedimentary rocks in a molten condition at the time of the formation of the mountain system. I can find no phenomena in any portion of the Coast ranges to support the view that the granite simply underlies the pre-Cretaceous series, but it seems always to have been the agent of upheaval and metamorphism.

Dr. Becker in his monograph on the quicksilver deposits, says: "At the Comstock and at Steamboat Springs, as well as on the eastern slope of the Sierra, granite immediately underlies strata at least as old as the Mesozoic. In the Coast ranges, also, Neocomian beds rest upon it. No distinctly intrusive granite of Mesozoic or Tertiary age has been recognized in the present investigation. That such exists, as asserted by Prof. Whitney, I by no means deny; but there is at least some ground for supposing that the main part of the rock is Archæan." *

In another publication speaking of some Triassic beds inclosed in the granite of the high Sierras, Dr. Becker says: "The main mass of the granite of the Sierra is earlier than the Aucella beds and in part at least later than these Triassic beds." †

My work has led me over à great part of the Coast ranges from San Diego to Siskiyou counties, and along much of the

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* Geology of the Quicksilver Deposits, page 141.

† Bull. Geological Soc. of America, Vol. 2, page 208.

western slope of the Sierra Nevadas, and I have not yet seen any granite which I believe could be correctly termed Archæan. It seems to have been squeezed into rocks varying in age from the Jurassic to Palæozoic inclusive. The time of intrusion except in some minor instances seems to have been as before stated, at the close of the Jurassic. It is possible that there are areas of older granites in eastern California, but I do not know that the presence of any extensive formation has been positively recognized.

The Metamorphic series in the Coast ranges contains a great variety of intrusives of all ages, from the late Tertiary lavas to the most ancient and highly altered ones whose original character has often been completely lost, and a part of which probably antedate the great upheaval.

As great as is the time gap between the periods of sedimentation represented by the pre-Cretaceous series and the Miocene which rests upon it, yet in places they are with difficulty distinguished from each other. Particularly is this so in San Luis Obispo county. The older series however everywhere show the effects of intense crushing.

A vast amount of detail yet remains to be worked out in the Coast range geology, but I believe the facts already known warrant us in assuming as a basis of future work that the axes of the Coast range are structurally closely related to the Sierras, and were first raised during the post-Jurassic upheaval, which at least if it did not originate the Sierra axis gave it its present magnitude and approximate elevation. It thus appears that during Palæozoic and early Mesozoic times the region occupied by these two important ranges was beneath the sea, receiving sediments probably from an eastern continental area, and save for disturbances which thus far have been recognized only locally, the sedimentation was continuous; and that if as old formations are not in the future recognized in the Coast ranges as have already been found in the Sierras, it is because of the less violence of the post-Jurassic upheaval in the former region, and the consequent non exposure of the deeper seated sedimentary strata.

LAKE FILLING IN THE ADIRONDACK REGION.

By C. H. SMYTH, JR., Clinton, N. Y.

Of the phenomena attendant upon the circulation of meteoric waters, none is more familiar to geologists than the obliteration of lakes by the deposition of sediment and the cutting down of outlets. While both actions go on simultaneously, in any specific case the one or the other may be the dominant factor. But, in either event, the destruction of the lake is the final result; and thus it is that lakes are taken as indicating an incomplete drainage system, and, to a certain extent, a new topography.

Such a perfect example of lake filling is furnished by the lakes and natural meadows of the Adirondack region, that these seem to merit more attention than they have hitherto received. In their economic aspect the natural meadows, or vlies, have been considered by Emmons,* but as an instance of lake filling they seem to have been neglected.

It is not the mere presence of these vlies that makes the region most interesting in this connection, but the fact that there is a complete gradation from lakes having almost their original extent and outlines, to those which have been entirely filled, forming vlies.

This series is well exhibited in the region about the head waters of the West Canada creek, the largest southward flowing stream on the west side of the Adirondacks. The two main branches of the creek have their origin in the lakes of Hamilton county; and, flowing in a southwesterly course, some six or eight miles apart, unite at Noblesboro, Herkimer county, forming a considerable stream which empties into the Mohawk, at Herkimer. These two branches of the creek are separated by an elevation of land, from seven to twelve hundred feet above the bottoms of the adjacent valleys and between two and three thousand feet above sea level.† This elevated area is made up of irregular ridges of gray and red gneiss, having a general northeast trend corresponding with the strike of the rocks. Small lakes, ranging from a few rods to three or four miles in greatest diameter, occupy many of the depressions between these ridges.

* Geol. of N. Y., II. p. 417.

† All elevations given in this paper are derived from a limited number of aneroid measurements based upon a railroad level thirty miles away, and must, therefore, be considered as only approximate.

The origin of the lakes is perfectly apparent: they are the result of the damming up of old lines of drainage by glacial detritus. The amount of material deposited by the ice sheet is very small as compared with the heavy masses found in other parts of the state, in this elevated region the soil being always thin or entirely wanting. However, the topography, high, steep ridges separated by narrow valleys, is such that a comparatively small amount of drift has been enough to materially interfere with the drainage, and thus form the lakes. As a matter of fact, the lakes are the best indication of glacial action to be seen in this region; for the character of the rocks is such that they have not preserved scorings, transported boulders cannot be distinguished from the country rock, and sections of glacial deposits are very few. The only clear indication of ice invasion, besides the lakes, is the common occurence of roches moutonnées.

Wilmurt lake, five miles northwest of Morehouseville, Hamilton county, furnishes an instance where the filling has but slightly changed the original outlines. It is about one and one-half miles long and one-fourth as wide, with gently sloping shores of sandy till covered with soft, spongy forest soil. That these shores are original and in no degree the result of deposition from the lake at a higher level, is perfectly clear from their contour and from the character of the materials composing them. A few rods back from the lake the east and west banks become steep; particularly the former, where there is a considerable cliff, and an elevation of four to five hundred feet above the lake within half a mile. The north and south banks, on the other hand, are rather flat; the former rising a little and then dropping rapidly; while through the latter is afforded an easy outlet for the waters of the lake. The preglacial valley in which the lake lies is thus clearly defined; and it is evident that the water of the lake is derived from a very limited area. The visible inlets are but four in number, all very small, most of the water reaching the lake by soaking through the spongy soil. From this fact it follows that very little sediment is brought in; hence the slight change of outline, which is limited to the shores adjacent to the mouths of the inlets. Of course, sediment is distributed to a greater or less extent over the whole lake bottom, but this does not affect the surface outline. A large flat island near the western shore, appears, at first glance, to be a result of sedimentation; but closer

inspection shows that it is chiefly composed of glacial material, its original extent having been somewhat increased by the growth and decay of marsh plants.

One mile and a half northeast of Wilmurt, lies Big Rock lake; about equal to Wilmurt in size, but much more irregular in outline, the rocky shore being indented by several small bays. The erosion valley occupied by the main body of the lake extends nearly east and west, while a large arm or bay swings off in a northerly direction. This bay differs from the main body of the lake in that its shores are very steep, almost vertical, running down into thirty or forty feet of water. Five rods west of the shore is a vertical cliff of brown gneiss, and still farther west a deep ravine with vertical walls and no flowing water through it. The valley occupied by the northern arm of the lake is extended a mile or more by a similar ravine. The whole topography suggests that this portion of the lake basin is not the result of erosion alone, but owes its existence in part to orographic movements.

Big Rock lake lies one hundred and fifty feet lower than Wilmurt; and receives the drainage of a larger territority. Several streams flow into it bringing with them a considerable amount of sediment, which has had a marked effect upon the outline of the lake. This is most noticeable on the southern side, where the two largest and swiftest streams empty. One of these has filled a shallow bay and built out a little into the lake. The other has almost wholly filled a long narrow bay, whose original shores are sharply defined. The area formerly covered by water is now a level, marshy meadow; its surface about a foot above the ordinary level of the lake, and covered with a heavy growth of grass and a few small balsams and tamaracks. Through this meadow the stream that has built it flows slowly, in a sinuous course.

At Wilmurt, in the shoaling of the water about the mouths of streams, with the attendant growth of water and marsh plants, is illustrated the very earliest stage in the developement of a vly; in this Big Rock Meadow is shown completed a portion of a vly which will ultimately occupy the place of the whole lake, unless there shall be some disturbance of the forces now acting.

The next stage in the series is shown in Little Rock and Snag lakes, the former two miles west of Big Rock, the latter one mile

north of Wilmurt. Both lakes are very small, measured by rods. rather than miles; and lie in sharply defined basins, enclosed by high hills. Both are partially surrounded by strips of meadow of varying width, through which the inlets flow in winding courses. As at Big Rock, the meadows lie a little above the ordinary water level: and their origin is equally clear. But here the process has gone farther, resulting in a reduction in the size of the lakes amounting to one-quarter or one-third of their original area.

Further illustrations of the process are afforded in a large number of nameless lakes lying from two to ten miles north and west of Big Rock in a region unmapped and without trails. Here are lakes wholly, instead of partially, surrounded by meadow. In some cases the width of meadow is small as compared with the area of the lake; in other cases, very large. In the latter event, the lakes are sometimes so shallow that water lilies cover the entire surface. Of lakes in this stage there are many examples. Tracing the process still farther, instances are found where the meadow has grown at the expense of the lake till the latter is reduced to a tiny pond; and finally, when this has been filled, there is left a level meadow, through which flows a winding, sluggish stream.

These meadows or vlies, of course, vary as greatly in size and shape as do the lakes from which they are derived. A large one lies less than a mile east of Wilmurt lake nearly equaling the latter in size. It is covered with tall grass and around the edges a few trees are scattered. A small stream, in its upper part, consisting of two branches, winds through the vly and runs into Big Rock lake, a mile distant. After heavy rains the stream floods the entire vly to the depth of a foot or more, spreading over it a greater or less amount of sediment. In every respect, except its completeness, this vly, which may be taken as a type of the class, is identical with the small meadows at the mouths of inlets of the various lakes. It is clearly the last stage in the process by which these meadows are now growing. Other vlies contain islands, rising above the general level, and covered with a forest growth, precisely like the islands in existing lakes.

While there can be no doubt that the deposition of sediment is the chief factor in the conversion of lakes into vlies, the growth

and decay of vegetation should not be overlooked. As soon as the water becomes sufficiently shallow, water lillies spring up, and after these rushes and other water plants, all of which contribute something toward land making. As shoal water is replaced by land, the mosses develope in abundance and become an important factor in raising the surface; while at the same time sedimentation becomes of less moment, being limited to periods of high water. Sometimes considerable portions of a vly are covered with this wet, spongy moss. The partially decayed moss, together with sediment deposited by floods, gradually raises the surface till it becomes sufficiently dry and firm to support grass and, finally, trees, of which tamarack is always most abundant.

The conditions prevailing during the formation of a vly are sometimes favorable for the production of peat; and that it has formed has often been proved, as stated by Emmons.* In the particular region under consideration, it has never, to the writers knowledge, been sought for. As peat results from the accumulation of decomposing vegetable material, its formation would be confined chiefly to the later stages of vly building when sedimentation is of minor importance.

A striking feature brought out by the examination of these lakes is the great difference in the rate of filling in different cases. The time during which the process has been going on is the same for all, and yet the effect produced varies greatly. The explanation is self evident; the rate of filling depends upon several conditions, the most important being the number, size and current of inlets, and the character of the surface over which they flow. The effect produced upon a lake's outline by a given amount of sediment depends upon the area and the depth of water. As there is the utmost variation in these conditions, there is a corresponding variation in the results attained in a given time. Thus, a lake which, like Wilmurt, receives most of its water by soakage through the soil, shows very little effect of filling; while the lakes that are fed by swift streams always show some surface change, even when deep and of considerable size. An apparent exception to this rule is shown in Metcalf lake, about two miles long, reached by a trail of a mile and a half from Big Rock. This lake is fed at its upper end by a considerable

* Geol. of N. Y., II, p. 417.

stream and yet shows very little filling. The reason for this becomes apparent on following up the inlet for a few rods. The stream is found to flow out of a small lake, which serves as a catch basin for the sediment brought from above, and is, in consequence, very near the vly stage.

The foregoing facts clearly indicate that the obliteration of lakes in the region described has resulted from sedimentation, rather than from a cutting down of the outlets. Professor Chamberlin applies the latter explanation to certain swamps and peat bogs of Wisconsin;* but the cases do not seem to be quite parallel.

While in some of the Adirondack lakes both causes may have worked together, there is no evidence that such has been the case. A great objection to such a supposition is, that in no instance that has come under the writer's observation is there any evidence that the lakes ever stood for any length of time at a higher level. Had they done so, there would have been formed the same marginal meadows that are forming to-day, and some traces of these meadows ought, surely, to exist as terraces at the present time. But of such there is no indication.

In some instances it is demonstrable that the lake never stood at any considerable elevation above its present level. Wilmurt lake is, perhaps, the best example. Some years ago the outlet was obstructed by a dam two feet high, with the result that an entirely new outlet was formed. Clearly, the lake never stood more than two feet above its present level, for had it done so, the barrier across the old outlet must have been higher than the artificial dam and the water would have flowed through the present outlet. It may be argued that these facts favor the idea that vlies are due to a cutting down of the outlet, for here, where it is proved that there has been no such cutting, there has been but small progress made towards a vly. But sufficient reason for this has been already given, in stating that very little water reaches the lake through streams. Furthermore, the effect of deposition has been somewhat, though slightly, obscured by the recent raising of the water level.

Hamilton College, Clinton, N. Y., October, 1892.

* Geol. of Wis., Vol. II, p. 240.

THE MAGNESIAN SERIES OF THE OZARK UPLIFT.

FRANK L. NASON, Geological Survey of Missouri, Jefferson City, Mo.

During the writer's study of the iron ores of Missouri, the question as to the position of the iron ores relative to the Magnesian or Ozark series became one of prime importance. Dr. A. Schmidt, in his report on the iron ores (Geological Survey of Missouri, 1872), definitely refers to the specular ores *in* the "Second Sandstone," and to the limonites generally *on* the "Third Magnesian." The same views were retained in the report of Prof. Broadhead in 1873. In the earlier surveys whenever mention is made of the specular iron ores of the above series of rocks, they are also placed *in* the "Second Sandstone."

Without going into the minute history of the origin of the terms "First, Second and Third Magnesian limestone," "First, Second and Third sandstone," etc., it will be sufficient for the present to state that the position of the specular ores was found to be in cave-like excavations in the so-called Third Magnesian limestone and *under* instead of *in* the so-called second sandstone.

The next point to be settled, as far as possible, was to determine the source of these extensive and numerous deposits. Their existence in caves showed conclusively that the iron was of secondary origin, probably derived from the leaching of superincumbent rocks. The leached rocks, according to the earlier geologists, must have been, Second Magnesian limestone; First sandstone and First magnesian limestone. Farther, if the Lower Carboniferous and Coal Measures rocks extended over the "Ozark uplift," these also would contribute their quota of iron to the specular deposits.

With the view of settling the point as to the existence of even traces of the Lower Carboniferous rocks, and also of determining the approximate thickness of the First sandstone, it was determined to study a section across the entire Ozark uplift from north to south. As has been explained very carefully by Pumpelly and by Broadhead, the Ozark mountains are really no mountains at all. There is a great anti-clinal fold running southwest from St. Louis. The drainage from this great area which Prof. Broadhead has very happily called the *Ozark uplift*, has resulted in the formation of great streams. These streams, flowing to the great drainage valleys of the Missouri and of the Mississippi rivers, have, near their mouths, cut deeply into the strata of rocks which form the uplift. On this account it was inferred that by following two or

more of these streams down the opposite slopes of the Ozarks, a section, showing the succession of sandstone and limestone, would be found.

Accordingly a boat trip down the Big Piney from Cabool, near the highest point of the Ozarks, to where the Big Piney empties into the Gasconade and thence down this last river to the Missouri, was made. For the section down the southern slope of the Ozarks, current was followed from Riverside, in Shannon county, to Doniphan, in Ripley county, and near the Arkansas and Missouri line.

In the vicinity of Cedar gap, thirty miles west of Cabool, on the K. C. M. & B. R. R., the younger rocks, Lower Carboniferous, are found in contact with a Magnesian limestone. From Cedar gap to Cabool there is a succession of limestone and sandstone outcrops. The limestone for the most part appearing on the higher ridges, the sandstones in the depressions. No detailed work was done here, only observations made from freight trains which stopped at every station for several minutes. The higher hills appear to be covered with a shaly limestone which doubtless belongs to the younger formation.

The above observations are valuable only as they seem to supplement the fact that Lower Carboniferous fossils in chert were frequently found on the higher bluffs down both the northern and the southern slopes of the uplift. It is thus probable that the Lower Carboniferous once extended over the entire Ozark uplift. In the vicinity of Cabool limestone of the Magnesian series covered nearly the entire rock outcrop. Near the Big Piney, however, and in the drainage basins leading into it, sandstone, ripple-marked, in places saccharoidal, in others flinty, is a common rock.

In the Big Piney itself, about eight miles from Cabool, flinty, ripple-marked sandstone appears covered by heavy beds of clay. These clays farther down become interstratified with argillaceous and cherty limestones, and these, where the river cuts deepen, by beds of limestone lying on top of the sandstone.

Farther down the stream heavy beds of sandstone appear capping the higher bluffs which often rise precipitously from one hundred to five hundred feet. In, or rather *on*, many of the bluffs no sandstone appeared near the river, but following the rise back from the river a distance of from one-half of a mile to a mile,

heavy beds of sandstone were usually found. That is, the sandstone found at the river level near Cabool was getting higher and higher above it.

Another fact worthy of note is that the sandstones are often lenticular. A thick bed of sandstone would occasionally show a thin seam of limestone. In a succeeding bluff the limestone would increase to the point of reducing the sandstone to a thin seam, and the next bluff would show the sandstone at its normal thickness again. Two or three layers of this sandstone and limestone occasionally appear. But without this thickening and thinning in lenses, one fact is very readily apparent, the sandstones never lose their own but are growing higher and higher in altitude as the river reaches its lower level; and, as the country is cut deeper and more numerously by adjacent as well as tributary streams, the sandstones form, often broken, caps on the limestone of the divides. In spite of the fact that occasional lenses of sandstone or gritty layers are formed in the limestone, the limestones, as the sandstones retreat above and from the river to the highest points of the divides, are growing purer, more heavily bedded, and thicker toward the Missouri river.

When the Missouri river is reached we find that the sandstone with which we started at Cabool has been persistent, and the only persistent bed of sandstone, and that from being the surface rock continuously bedded at the river level at Cabool, it now caps the bluffs which rise sheer from the Missouri river, east of Gasconade City, to the height of over three hundred feet. Without going into detail, it may be pointed out that the section down Current river shows the same phases which have been pointed out above. The highest hills on this river are about six hundred feet above the river and they are practically solid limestone from the river to the more or less broken cap of sandstone which usually is found on the summits of the hills. Conclusive as such sections are, with respect to establishing the continuity of a given bed, there are often concurrent facts which almost, if not entirely, remove all doubts.

In the Ozark series fossils have rarely been found. Casts in loose chert, which has evidently come from the decomposing Magnesian limestones, are frequently met with, but this chert has rarely been found *in situ*. During the excursion down the rivers search was made for fossil localities which might serve as a means of identifying widely separated rock strata. This search was re-

warded with success far beyond the writer's expectations. Soon after beginning the river section on the Big Piney, a fossil stratum was found lying between the limestone below and the sandstone above. This stratum with fossils was found in every bluff from Cabool to Gasconade City, and from Riverside to Doniphan. Numerous specimens were collected and are now in the survey collections at Jefferson City.

At the writer's request Prof. R. R. Rowley visited several of the noticed localities. He writes that the stratum was easily found from the writer's description and could easily be recognized at widely separated localities.

In addition to the above localities, the writer has found fossils of a similar nature *in situ* at Cherry Valley Iron bank. In widely separated areas throughout the entire extent of the Ozarks the writer has found fossils in chert similar to the ones found in the river sections. In every case they were found in chert *below* outcrops of sandstone, never *above*. These fossils have been found in areas which have been described as "First sandstone." Summing up the results of the study of the above sections, the writer arrives at the following conclusions:

First.—That the bed of sandstone in which are located the deposits of specular iron ore in Crawford, Dent, Phelps, Pulaski, Texas, and other counties are continuous and are synchronous with the beds of sandstone followed down the northern and southern slopes of the Ozarks. *Second;* that this is the only bed of sandstone of any importance, exposed within the region. *Third;* that the terms "First," "Second" and "Third" sandstone are not based on sufficient evidence to warrant their retention. In fact that these terms have been applied to the same bed in different parts of the Ozark mountains.

In view of the above facts, the writer proposes that in place of the above terms the name Roubidoux be applied to the bed of sandstone above described; and that to the heavy beds of limestone occurring *under* the above sandstone be applied the name Gasconade. These terms being taken from the streams along which these rocks typically occur.

If any one cares to become acquainted with the detailed reasons for the above conclusions, he will find them, together with careful sections in the forthcoming report on the "Iron Ores of Missouri," published by the Missouri Geological Survey.

SECOND SUPPLEMENT TO "MAPOTECA GEOLOGICA AMERICANA," 1752-1881.

By JULES MARCOU, Cambridge, Mass.

The number between brackets shows the correct position of the map or addition in the general catalogue, *Bulletin United States Geological Survey*, No. 7, Washington, 1884.

NOTA BENE.—This second supplement list, with some remarks on maps already quoted in the "Mapoteca," has been prepared with the help of Messrs. E. A. Smith, A. W. Vogdes, Gustav Steinmann, A. del Castillo, H. W. Clarke, S. H. Scudder, and J. B. Marcou. I have been unable to get the full title and dates of two geological maps; one by Mr. Rothwell, of the northern anthracite basin, and the other by Mr. C. R. Boyd, of Southwest Virginia, which have been kindly pointed out to me.

I.—*America in general, comprising both North and South America.*

[1.]

Addition.—The "Carte géologique du globe terrestre," by A. Boué, was presented 22d September, 1843, at the meeting of the German naturalists at Gratz; and at the Geological Society of France, the 5th of February, 1844 (*Bulletin Soc. Geol.*, 2d series, tome. I, p. 266.) An explanation under the title: "Mémoire a l'appui d'un essai de Carte géologique du globe terrestre, etc.," was published in the same volume of the *Bulletin Soc. Geol.*, at pp. 296-371.

The map printed and colored mechanically, by Le Blanc, captain of Engineers, French army, was issued the 15th of February, 1845. But owing to some defects, the distribution was stopped soon after—only twenty copies having been sold—and the whole edition was not issued truly until the spring of 1846.

II.—*North America in general, etc.*

[25.]

Addition.—The first map of William Maclure of 1809 is without his name, which was carelessly omitted; and as a consequence it is sometimes credited to Samuel G. Lewis, the draftsman.

925 [26 a.]

1814.—De Beaujeu (Felix) le Chevalier. Map of the United States (Carte des Etats-Unis, dressé par P. Lapie.) Accompanying: "Sketch of the United States of North America, at the commencement of the nineteenth century, from 1800 to 1810." Translated from the French by William Walton, London, 1814.

Almost a copy of Maclure's Geological map of 1809, with some additions for Texas and Canada, and a few alterations. The principal difference being that the colors are placed only in contour forms, not as "teinte plate." The description of the map is called "Surface of the Land," from p. 41 to p. 52.

[31.]

Addition.—The place of publication is Boston, Massachusetts. The map is accompanied by an explanatory text entitled: "A concise description of the geological formations and mineral localities of the western states designed as a key to the geological map of the same, by Byrem Lawrence," Boston, 1843, pp. 48.

926 [59 a.]

1866.—Logan (Sir W. E.), Geological map of Canada and the adjacent regions, including the other British provinces, and parts of the United States. Scales 25 miles to one inch; in eight sheets.

The preceding map No. 59, with exactly the same title and the same coloring, is a reduction in one small sheet of the great map in eight sheets.

III.—*Arctic America, etc.*

927 [89 a.]

1869.—Packard, Jr. (A. S.) Map of a portion of the coast of Labrador.

Accompanying: "Observations on the glacial phenomena of Labrador and Maine, etc.," in *Memoirs, Boston Soc. Nat. Hist.*, vol. I, plate 8, p. 210, Boston, Oct., 1865, issued in 1869.

The map contains the coast only from the strait of Belle Isle to Davis inlet. Black etchings.

VIII.—*New York and New Jersey.*

928 [241 a.]

1844.—Emmons (E.) Agricultural and Geological map of the State of New York by legislative authority. Four sheets. Engraved and printed in New York, 1844.

Accompanying: Agriculture of New York, vol. I. Albany, 1846.

It is the map spoken of at No. 239 of the *Mapoteca Geologica Americana*, p. 59, as "stolen or destroyed by persons unknown." This most important map and the only exact one of the whole state of New York and a part of Massachusetts, by Dr. Ebenezer Emmons, con-

taining his great discovery of the Taconic system, well represented and colored, instead of being destroyed as Emmons thought, was only concealed in the cellars of the State House of New York, at Albany. It was not issued during the lifetime of Dr. Emmons; but in 1877 some mutilated copies were distributed by the State Librarian at Albany, as the real Geological map of the state of New York. Finally, in 1887, the map as dressed and colored by Emmons, with its full title, has at last come out from the cellars of the New York's Capitol. The suppression of the map during Emmons' life, and many years afterward, was due to the existence of the Taconic system, opposed by certain person or persons bound together to its destruction, not only as a system, but even as to its existence below the Potsdam sandstone considered wrongly by them as the oldest or bottom stratified beds in America.

928 [244 a.]

1859.—Geddes (Geo.), assisted by H. W. Clarke and D. L. Sweet. Geological map of Onondaga county, N. Y. Scale about 1.6 miles to one inch.

Accompanying: "Report upon the Geology, etc., of Onondaga county;" published by the New York State Agricultural Society in its "Transactions for 1859, Albany."

930 [244 b.]

1859.—French (?). Geological map of New York. Small scale; printed in the margin of French's map of New York. New York ? 1859.

Black etching.

IX.—*Pennsylvania, Delaware and Maryland.*

931 [274 a.]

1837.—Rogers (H. D.) Map of Chester county.

Accompanying: "Flora Cestrica, etc.," in "Plants of Chester county in the state of Pennsylvania," by William Darlington, West Chester, Penn., 1837.

The name of the author is not inscribed on the map, but is indicated in the preface page vii. A second edition of that map appeared with the third edition of the "Flora Cestrica," by William Darlington, Philadelphia, 1853; but no reference is made of its authorship by Henry D. Rogers, although the same geological map as the one of 1837.

932 [285 a.]

1864.—Sheafer (P. W.) Official coal, iron, railroad and canal map of Pennsylvania, etc., showing the relative position of the various anthracite and bituminous coal fields, etc., by authority of the legislature of Pennsylvania, Pottsville, Pa., 1864.

Black etching.

XII.—*Southern States.*

933 [541 a.]

1835.—Conrad (T. A.). Geological map of Alabama. Accompanying: "Fossil shells of the Tertiary formations of North America," vol. I, No. 3. Title of No. 3: "Eocene fossils of Clairborne, with observations on this formation in the United States, and a Geological map of Alabama." Republished with plates (four plates), March 1, 1835, Philadelphia.

This map, like the first geological map of Maclure, described under No. 25, is without the name of its author, and may be attributed to the draftsman, H. S. Tanner, the compiler and publisher of the geographical map on which Conrad put his geological classification and colors.

Less than half a dozen of No. 3 Conrad's "Fossil shells of the Tertiary, etc.," are in existence. Owing to a foot note at page 36, someone interested in the notes purchased the whole edition and suppressed it. Two reprints, one without the foot note and without the geological map, and a second one with the foot note and the map, has the same fate. No copies have ever reached Europe. Sir Charles Lyell, during his first journey in America, in 1842, received from Conrad a copy of his Geological map of Alabama. (*Travels in North America in the years 1841-42*, vol. II, p. 204, New York and London, 1845.)

XVIII.—*Mexico.*

934 [801 a.]

1803.—Humboldt (A. de) Esquisse géologique des environs de Guanajuato, fondée sur des mesures géodésiques et barométriques faites en aout et Septembre, 1803, Paris.

935 [801 b.]

1807.—Humboldt (A de) Carte géologique du Nevado de Antisana, esquisée sur les lieux. Paris.

936 [801 c.]

1827.—Gerolt (F. de) and Berghes (C. de) Carta geognostica de los principales distritos minerales del Estado de Mexico, formada sobre observaciones astronomicas, barometricas y mineralogicas hechas por F. de Gerolt agenta y C. de Berghes. Mexico.

937 [804 a.]

1844.—Garay (José de) A Geological map, accompanying: "Reconocimiento del istmo de Tehuantepec, practicado en los annos 1842 y 43 con el objeto de una communicacion Oceanica, por la comission cientifica que nombro al efecto el impressaria Don José de Garay," London, 1844.

938 [804 c.]

1860.—Anonymous. Geological map of the southern part of the isthmus of Tehuantepec. No place of publication.

XXIV.—*Paraguay, Patagonia and Tierra del Fuego.*

939 [852 a.]

1847.—Grange (J.) Carte géologique de la Patagoine et de la Terre de Feu. Scale 1: 1,150,000.
Accompanying: "Voyage au pôle sud et dans l'Océanie," par Dumont d'Urville, Géologie; atlas in folio, Carte No. 2, Paris, 1847.

[NOTES ON PALÆOZOIC CRUSTACEÆ NO. 3.]

ON THE GENUS AMPYX WITH DESCRIPTIONS OF AMERICAN SPECIES.

By A. W. VOGDES, Alcatraz Island, San Francisco, Cal.

Historical notice of the genus Ampyx Dalman 1828.

1828.—Dalman describes and figures the first species of this genus under the name of *Ampyx nasutus* from the Lower Silurian of East Gothland at Skarpasen. This new genus is classified under Section v, family *Asaphus* (*Ampyx*) *nasutus* Palæaden p. 53, plate 5, fig. 3. The author gives the following brief description of the genus: "Eyes not apparent nor even protuberances in their place, but rather impressions; head large and triangular; glabella very large, prominent gibbous, and not lobed; thorax short with few segments (6); pygidium distinct and entire." This species has been described and illustrated by numerous authors.

1835.—Sars describes and figures in Isis, Heft 4, p. 334, plate 8, figs. 9 and 4, two new species from the Lower Silurian of Norway under the names of *Ampyx rostratus* and *A. mammillatus*. The glabella of *Ampyx mammillatus* is represented on plate 8, fig. 4c as blunt in front, less so in fig. 4a, and elongated in fig. 4b. It is doubtful whether all these figures are of the same species, Boeck, Gea Norvegica, 1838, p. 144 expresses this view, but the author does not suggest a new name for the species. Angelin (Palæontologia Scandinavica, 1854 p. 80) restricts the name of *Ampyx mammillatus* to Sars' figure 4c, and gives that of *Ampyx costatus* Boeck, to figs. 4a-b-d apparently from a term used by Boeck in the naming of species in the Christiania Musuem.

1843.—Portlock in his report on the Geology of Londonderry, etc., p. 258, gives a generic description copied after Dalman's; the author also describes and illustrates two Irish species from the Lower Silurian, which he considers identical with those described by Sars in 1835. Col. Portlock remarks: "If *Ampyx nasutus* Dalm. was provided with a frontal spine, it is equally probable that if perfect it would have exhibited lateral buckler spines also, and hence these appendages

must be considered rather generic than specific distinctions. As the terms *nasutus* and *rostratus* are therefore inappropriate as specific designations, they should be replaced by others not tending to confound generic with specific characters, and *Ampyx nasutus* might be called after its discoverer *Ampyx dalmani*, and *Ampyx rostratus*, *Ampyx sarsii*." The author expresses a doubt if all the figures of *Ampyx mammillatus* given by Sars are one and the same species. He describes and illustrates *Ampyx austini* which has hitherto been regarded as a synonym of the older species, *Ampyx mammillatus*. *Ampyx bacatus* Portlock is probably the head of a species of the genus Encriminurus; it is indistinctly illustrated.

1846.—Barrande describes in his preliminary work, Nouv. Trilob. p. 9, *Ampyx portlocki*, which has five segments in the thorax.

Corda describes and figures under the name of *Ampyx bohemicus*, a species to which Barrande had already given the name of *Ampyx portlockii*. Prodrom, 1847, p. 154, pl. 3, fig. 19.

1847.—Boll, in Dunk & Meyer's Palæont. Bd 1, Liefg. 2, pl. 17, fig. 8, describes and figures *Ampyx bruckneri*, a new species from an erratic boulder.

1848.—Forbes describes and illustrates in the Mem. Geol. Sur., vol. 2, part 1, page 350, a new species from the Upper Silurian.of Ludlow, England, under the name of *Ampyx parvulus*, which he figures on plate 10; it has only 5 thorax segments.

1849.—Forbes, in the Mem. Geol. Sur. Decade II, plate 10, describes and illustrates *Ampyx nudus*, a species which Murchison had classed under the genus Trinucleus, in his Silurian Syst. 1839, p. 660. Forbes divides the genus into two provisional sections as follows:

1. Ampyx proper with the head long and five thorax segments.
2. Brachampyx with the head short and round with six thorax segments.

The section Brachampyx is equivalent to Dalman's original genus *Ampyx*, of which *Ampyx nasutus* is the type, and is altogether misapplied; it should be abandoned.

1850.—McCoy, in Annals Mag. Nat. His., series 2, vol. 4, p. 410, gives a classification of English trilobites. He enumerates the genus *Ampyx* under the Ogygidæ. The author also describes a new species under the name of *Ampyx latus*, with five thorax segments; cf. *Ampyx nudus* which occurs near Builth, Wales, the locality given for this fossil.

1854.—Angelin, Palæontologia Scandinavica, p. 80, proposed the following subdivisions of the genus *Ampyx*. *Raphiophoridæ* with three genera.

1. Lonchodomus Ang., with lancelate glabella terminating in an elongated prismatic spine; type *Ampyx rostratus* Sars.
2. Ampyx Dalm., with an oval glabella terminating in a rounded spine, six thorax segments; type *Ampyx costatus* Boeck.
3. Raphiophorus Ang., with an obovate glabella having an abrupt apical spine, five thorax segments; type *A. seterostris* Ang.

The author describes and illustrates *Ampyx costatus* Boeck taking Sars' figure of *Ampyx mammillatus*. Isis 1835, plate 8, figs. 4a-b and d

for the type of the species. On comparing Angelin's illustrations of *Ampyx costatus* given on plate 40, fig. 1, we observe that they resemble Sars's figure given on pl. 8, fig. 4b, Isis, 1835; as to having a produced glabella and spine, Sars' figures given on pl. 8, fig. 4a represent a species with a blunt glabella terminating in a tubercle; fig. 4b of the same plate has an extended glabella prolonged into a spine. Both these species do not appear to be the same, therefore Angelin's description of *Ampyx costatus* should be confined to Sars' fig. 4b, and *Ampyx mammillatus* should be restricted to Sars' figures of this species given on pl. 8, figs. 4a-c. These illustrations do not quite coincide, but they agree much better than fig. 4b. That both Boeck and Angelin were correct in splitting up *Ampyx mammillatus* Sars, there can be no doubt; it is a question of the correct separation. *Ampyx costatus* should not include the spined and non-spined glabella represented on Sars' pl. 8, figs. 4a-b, as Angelin, as reclassified it.

Angelin also describes and figures the following species:

Ampyx foveolatus Ang., Regiones D-E; *Ampyx mammillatus* Sars, Reg. Da; *Ampyx nasutus* Dalm., Reg. C; *Ampyx? aculeatus* Ang., Reg. Da; *Raphiophorus setirostris* Ang., Reg. Da; *R. tumidus* Ang., Reg. Da; *R. culminatus* Ang., Reg. Da; *R. depressa* Ang. Reg. Da; *R. scanicus* Ang., Reg. Da; *Lonchodomas rostratus*, Sars., Reg. Da; *L. crassirostris* Ang., Reg. Da; *L. affinis* Ang., Reg. Da; *L. jugatus* Ang., Reg. C; *L. domatus* Ang., Reg. B-C; *Ampyx tetragonus* Ang., Reg. C, and *A. carinatus* Ang., Reg.

1852.—Barrande in his great work Syst. Sil. Bohême, vol. I, p. 632, describes and figures *Ampyx rousalti*. He also redescribes *Ampyx portlocki* which is illustrated for the first time.

1857.—Eichwald in the Bull. Soc. Nat. Mosc., 1857, p. 318, describes *Ampyx nasutus* Dalm., *Lonchodomas affinis* Ang., and *Raphiophorus conulus* n. sp. These species are redescribed in Lethæa Rossica vol. I, p. 377. *Lonchodomas affinis* is classed under the new name of *L. longirostris* pl. 55, fig. 1, and *Raphiophorus conulus* is for the first time illustrated.

1866.—Salter describes and figures *Ampyx prænuntius* from the Upper Tremadoc in Mem. Geol. Sur. of Great Britian, Geol. of North Wales, p. 321, pl. 8, fig. 5.

1872—Barrande, in the Suppl. Syst. Sil. Bohême, vol. I, p. 48, plate 2, describes and figures *Ampyx gratus* and *A. tenellus*, Etage D-5.

1865.—Billings, in his work on the Palæozoic Fossils of Canada, vol. I, describes and figures *Ampyx halli*, *A. laeviusculus*, *A. normalis*, *A. rutilius*, and *A. semicostatus*, all Lower Silurian species.

1875.—Hicks, in the Quart. Jour. Geol. Soc., London, vol. XXXI, p. 182, plate 10, fig. 7-8, describes and figures a Lower Silurian species under the name of *Ampyx salteri*.

1878.—Haupt, in Die Fauna Grapt. Gesteines, p. 73, plate 5, fig. 7, describes *Ampyx? (brevinasutus)*, *Raphiophorus culminatus* Ang., *Ampyx* sp.

1879.—Nicholson & Etheridge, Mon. Sil. Fossils of Girvan District, describe and illustrate *Ampyx (Lonchodomas) rostratus* Sars, *Ampyx (Lonch.) macallumi* Salter, *Ampyx? maccconochiei* E. & N., *Ampyx hornei* E. & N.

1882.—Holm, in Svenska Vet. Akad. Handl., vol., VI No. 9, p. 12, plate 1, figs. 13 and 14, describes and figures a Lower Silurian species under the name of *Ampyx pater.*

1888.—Marr, in the Quart. Jour. Geol. Soc. London, vol. XVII, p. 724, fig. 17, describes *Ampyx (Raphiophorus) aloniensis.*

1889.—Vogdes & Safford, in the Proc. Acad. Nat. Sci., Phila., p. 166, figure and describe a Lower Silurian species under the name of *Ampyx Americanus.*

RECAPITULATION.

SECTION 1, BREVIFRONTES.—Glabella oval terminating in a rounded spine.

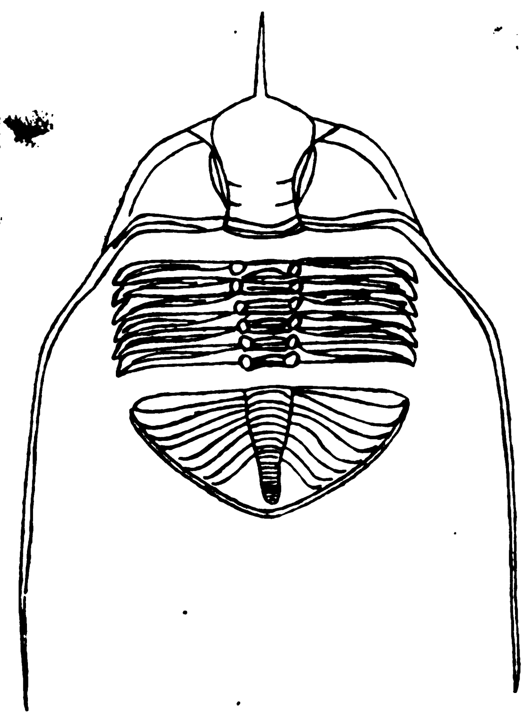


FIG. 1. *Ampyx nudus* MURCH.

Lower Silurian species:

1. Ampyx americanus Vogdes & Safford.
2. " bruckneri Boll.
3. " costatus Boeck.
4. " gratus Barrande.

5. Ampyx hornei Etheridge & Nicholson.
6. " mammillatus Sars.
7. " nudus Murch.
8. " praenuntius Salter.
9. " pater Holm.
10. " salteri Hicks.
11. " latus McCoy.
12. " brevinasutus Haulp.

SECTION 2, LONGIFRONTES. Glabella obtuse obovate with an abrupt spine.

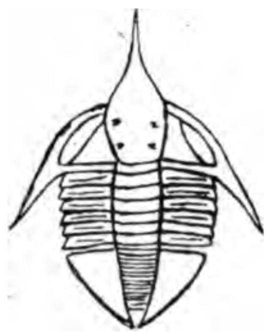


FIG. 2. *Ampyx nasutus* DAL.

Lower Silurian species.

1. Ampyx? aculeatus Ang.
2. Raphiophorus culminatus Ang.
3. Raphiophorus depressus Ang.
4. Ampyx halli Billings.
5. " nasutus Dalman.
6. " portlocki Barrande.
7. Raphiophorus scanicus Ang.
8. " setirostris Ang.
9. Ampyx tumidus Forbes.
10. " rutilius Billings. (pygidium only).
11. " semicostatus. (pygidium only.)
12. " tetragonus Ang.
13. Raphiophorus tumidus Ang. (not that of Forbes).
14. Ampyx tenellus Barrande.

Upper Silurian species.

15. Raphiophorus aloniensis Marr.
16. Ampyx foveolatus Ang.
17. " parvulus Forbes.
18. " rouaulti Barrande.
19. Raphiophorus conulus Eichwald.

SECTION 3. LONCHODOMAS, with a lanceolate glabella terminating in an elongated prismatic spine.

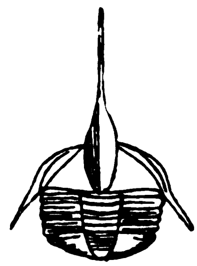


FIG. 3. *Lonchodomas domatus* ANG.

Lower Silurian species.

1. Lonchodomas affinis Ang.
2. " carinatus Ang.
3. " crassirostris Ang.
4. " domatus Ang.
5. " jugatus Ang.
6. " macallumi Salter.
7. Ampyx? macconochiei Etheridge & Nicholson.
8. Lonchodomas rostratus Sars.
9. Ampyx normalis Billings. (Head only; cf. *Ampyx rostratus* Sars.)
10. Ampyx laeviusculus Billings. (This is probably the tail of *Ampyx rostratus* Sars.
11. Lonchodomas longirostris Eich., cf. *L. affinis* Ang.

Genus AMPYX, Dalman, 1828.

Diagnosis.—Entire form oval, approaching the form of a lozenge. Trilobation marked in all its extent; the head is subtriangular, rarely provided with a limb but usually armed with long pointed spines. The glabella is generally distinctly defined by the dorsal furrows, which form a salient frontal lobe before the contour of the cheeks. In the section *Brevifrontes* the glabella is oval, terminated in front by a long pointed rounded spine as in *Ampyx nudus* Murch. and *A. costatus* Boeck, &c. In the section *Longifrontes* the glabella is obtuse-obovate with an abrupt spine as in *Ampyx nasutus* Dalm. In the section Lonchodomas the glabella is lanceolate in form terminating in an elogated prismatic spine as in *Ampyx rostratus* Sars. The number of the side furrows on the glabella varies much from three pairs as in *Ampyx mammillatus* Sars, to two in *Ampyx nudus* Murch, *Ampyx nasutus* Dalm. These furrows appear to be absent in the type of the section *Lonchodomas*, *Ampyx rostratus* Sars. The summit of the facial sutures occupies a marginal place and is hid under the

salient frontal. The facial sutures in *Ampyx rouaulti* Barr, run from the anterior borders of the glabella in an almost straight line to the posterior border which they cut near the genal angles near the ends of the first pleuræ; see also *Ampyx nasutus* Dalm and *A. domatus*. In *Ampyx costatus* Boeck, the facial sutures form a sigmodial curve cutting the anterior border about midway and the posterior border near the genal angles. The eyes are wanting. The hypostoma has not been observed. Occipital ring and furrow well defined. The thorax consists of six segments in *Ampyx nasutus*, *A. costatus*, &c. *Ampyx setirostris*, *A. porlocki*, *A. rouaulti*, *A. parvulus* and *A. latus* have only five segments. Barrande observes that in undeveloped specimens of *Ampyx rouaulti* there are only three or four segments in the thorax. The axis is always distinct: the lateral lobes form a plane surface, with horizontal pleuræ. They are sometimes marked with lateral rows of tubercles on the axis as in *Ampyx nudus*. The pleuræ are horizontal and divided by an oblique furrow which extends from the dorsal furrows to the tips: the knee occupies a place near the extremity, and forms a very short slope. The pygidium is subtriangular in outline, sometimes rounded, presenting a horizontal surface, with a prominent axis. The axis of *Ampyx rostratus* is faintly segmented with a row of tubercles on each side; that of *A. nudus* has nearly 20 articulations, and that of *A. tetragonus* shows no articulations. The lateral lobes are generally segmented.

NORTH AMERICAN SPECIES.

Brevifrontes.

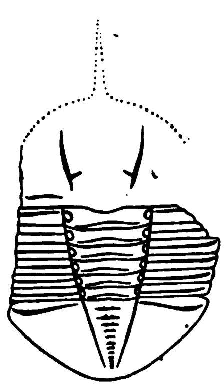


FIG. 4. *Ampyx americanus* VOG. & SAF.

AMPYX AMERICANUS Vogdes & Safford, 1889.

Diagnosis.—General outline broadly oval; glabella somewhat claviform, slightly convex, narrowing behind the middle and widening out slightly at its junction with the occipital ring; it is marked on each side by one or more oblique furrows; projecting spine broken off in the specimen before us. The cheeks are broad and rounded towards the margins; genal spines broken off; facial sutures not observed. The thorax has six horizontal segments; the axis is broad anteriorly and gradually diminishes posteriorly; it is well defined by the dorsal furrows and lateral nodes along its sides. The pleuræ are horizontal and deeply grooved, terminating in obtusely pointed ends like those of *Ampyx nudus* Murch. The pygidium is triangular in form; the axis is prominent and gently tapering to an obtuse point on the posterior border; it is marked by 13 or more rings with a central row of nodes; the sides have only one pair of side ribs which are deeply grooved outwards, cutting off the posterior part of the tail.

Geological position.—Trenton group near Bull's Gap, on the road to Russelville, Tennessee. Cabinet of J. M. Safford.

Affinities.—We have compared the Tennessee species with the 42 known species of the genus Ampyx, and find that it differs in detail from all of them. The American species is of the type *Ampyx nudus* Murch and *A. costatus* Boeck. There is a pygidium figured by Billings in Palæozoic Foss, Canada, vol. I, p. 295, fig. 285, as *Ampyx laviusculus* from Table Head N. F., which approaches the Tennessee species, but it lacks the nodes.

Longifrontes.

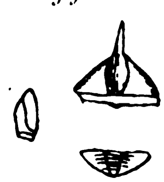


FIG. 5. *Ampyx halli* BILL.

AMPYX HALLI Billings, 1861.

Diagnosis.—Head somewhat triangular or semi-oval; glabella elongate-oval, terminating in front with an acute spine and truncated behind by the neck furrow, narrowly convex and rather sharply carinated along the median line; glabella furrows represented by two obscure indentations on each side, the posterior at a little less than one line from the neck segment, and the anterior about two lines; the latter consists of deep pits situated in the

dorsal furrows or just in the angle formed by the junction of the base of the glabella with the fixed cheeks. The neck segment is a flat plate inclining upwards and backwards at an angle of about 45 degrees. The neck furrow is well defined all across the whole width of the head, being least distinct in passing over the posterior part of the glabella. Pygidium semi-oval with a flat border all round abruptly bent down at nearly a right angle. Axis conical, moderately convex extending the whole length and causing a slight projection in the posterior margin. Side lobes nearly flat, with 5 or 6 flat ribs, each with a fine pleural grove extending the whole length. On the axis 10 or 12 closely crowded annulations occupying 5-6 the lengths: the apex being apparently smooth. Length of the head excluding the spine 3½ lines measured along the base of the glabella.

Geological position.—Chazy, St. Dominique, Canada East, and at Highgate Springs, Vermont.

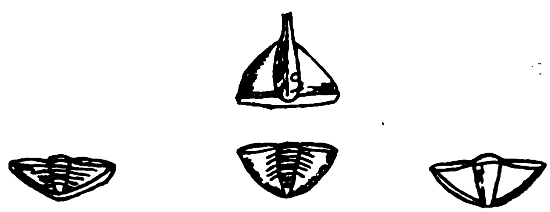


FIG. 6. *A. seimcostatus* BILL. *A. normalis* BILL. *A. lœviusculus* BILL.

AMPYX NORMALIS Billings, 1865.

Compare *Ampyx lœviusculus* Billings, & *A. rostratus* Sars.

Diagnosis.—Head, without the movable cheeks, triangular, the width about ⅓ greater than the length: fixed cheeks gently convex, smooth: neck segment consisting of a flat plate inclining backwards. The glabella elongate-oval, greatest width about mid-length, ¼ narrower at the neck segment, the apex extending a little over the front margin of the head: the spine apparently equal to the whole length of the head, not rounded but fluted, a charatcteristic of the spine of *Ampyx rostratus.* There are 2 or 3 ovate or nearly circular scars, one on each side of the glabella in the posterior half.

Of the two pygidia described from Table Head by Billings u nder the names of *Ampyx lœviusculus* and *A. normalis*, I think that the pygidium of *A. lœviusculus* should be connected with the

separate head described as *A. normalis*. The author remarks that the latter differs in being "proportionately wider, the posterior bevelled margin thicker and the upper edge of the bevel rounded instead of angular," which may be due to age or other causes. The sides of *A. laviusculus* are represented as quite smooth, but those of *A. normalis* are obscurely ribbed.

The pygidium of *Ampyx rostratus* has a broad, bevelled and striated limb. Axis faintly segmented with a row of nodes on each side, with the exception of the first segment, which is distinct. The side lobes have only one pair of anterior ribs.

The following is the original description of the pygidium of *A. normalis*: Pygidium triangular, width twice the length, the two posterior sides gently convex, and the margin abruptly bent down or bevelled nearly vertically, the upper edge of the bevel angular and with indications of a slightly elevated linear rim; axis very depressed, convex or nearly flat, its width at the anterior margin about ¼ of the whole width, extending the whole length or nearly so, crossed by obscure undulating furrows. Side lobes gently convex.

AMPYX RUTILIUS Billings, 1865.

Compare *Ampyx semicostatus* Billings, 1865.

Diagnosis.—Pygidium subtriangular, length about ⅓ of the width, nearly vertically bevelled behind, the upper edge of the bevel with an acute linear rim. Axis cylindro-conical, strongly convex, extending the whole length, with about 10 rounded rings. Side lobes nearly flat, slightly concave near the margin, with 9 ribs very distinctly defined the whole width. Width of the specimen 4 lines; length 1⅓ lines.

Locality.—Four miles N. E. from Portland Creek, Newfoundland.

Affinities.—The author remarks that this species differs from *Ampyx semicostatus*, in having more numerous ribs which also extend the whole width. It occurs along with it in the same beds.

The pygidium of *Ampyx laviusculus* differs from that of *A. normalis* in having a more prominent axis and a thicker posterior margin, also in being proportionately wider.

AMPYX SEMICOSTATUS Billings.

Diagnosis. -Pygidium sub-triangular, posterior margin broadly rounded, obtusely angular at the apex: length 2-5 of the width; axis cylindro conical, strongly convex, extending the whole

length, with 5 or 6 distinctly defined rounded annulations; dorsal furrows on each side of the axis, deep and well defined. The side lobes are rather tumid in the middle, but concave towards the margin, the latter with a distinctly elevated angular rim and nearly vertically bevelled; there are 5 or 6 ribs extending about half way from the margin of the axis. In very small specimens only 2 or 3 are visible.

Locality.—Table Head and Pistolet bay; four miles N. E. from Portland creek, Newfoundland.

EDITORIAL COMMENT.

The Illinois State Museum.

There is great activity in Illinois in numerous branches of practical geology and natural history. Not only is the Illinois Board of Managers of the Columbian Exposition constructing a plaster of paris map, moulded to show the contours of the surface, but preparations are being made to make a complete display of the rocks and fossils of the state. Maps and sections showing the geological structure, based on a long series of studies of rock outcrops and of deep wells, will show the underlying geology, while soil and surface maps will accompany the sections, calculated to not only exhibit the distribution of the drift, but also the effect of the rocky substructure on the soils in the absence of the drift. A new contoured map has been nearly completed, of the whole state, by Prof. C. W. Rolfe, of the State University, he having spent the wlole of last season, with a large corps of assistants, in topographical work. Mr. Lindahl, assisted in one direction by Mr. Frank Leverett, and in another by Mr. E. O. Ulrich, has had the responsible charge of the geological exhibit. He has fortunately gathered, during the last four years, a large addition to the available data for a practical study of the rocks of the state, supplementing and extending the paleontological researches of Prof. Worthen by stratigraphic measurements and actual sections in the field. Never before this gathering of the data of deep wells was it possible to construct profile sections

across the state with such accuracy. The Worthen collection, now catalogued in the Museum, numbers 2,879 entries, and the total entries reach 18,507, an increase, during the past four years, of 11,558. Numerous duplicate specimens have been assorted for distribution to the schools of the state. The library, wholly built up since Prof. Worthen's death, contains about 2,000 volumes, and as many pamphlets. In the records of the office are 400 logs of borings and shafts, with collateral information.

This growth, which entails a vast correspondence, and which is necessarily a growth that must go on, under the intelligent guidance and watchful inspection of one mind, during a series of years, cannot fail to be very useful to the State in the near future, if it is properly husbanded and mastered by comparative studies. It is evident that it cannot be easily picked up by any new man. It is a misfortune when from any cause such a chain of research is broken by change in the incumbency of the responsible position of state geologist. Geological science is, in its nature, necessarily a thing of slow progress, and it has suffered many losses and serious checks by the suicidal efforts of politicians to scatter the emoluments of partisan politics among their friends. The governor's chair can be emptied and filled annually, or semi-annually, by successive incumbents, and the state will not suffer, but the work of a geological bureau is connected and cumulative, and valuable only as its data are wisely collected and concentrated from the experience of several years, under the systematic plans of the same incumbent. This was perfectly illustrated by the long service of Worthen, in his persevering paleontological labors, and is again by that of Lindahl in his extensive stratigraphical and economic studies. Would that every State had the wisdom that is shown by Illinois in this work.

Some Recent Criticism.

The somewhat acrimonious assault upon Prof. G. F. Wright's late volume entitled "Man and the Glacial Period" has in some points exceeded the due bounds of scientific criticism if not those of courtesy. It is to be regretted that the reviewer should be lost in the assailant or that the pursuit of truth should be subordinated, or even seem to be subordinated, to the desire of personal

distinction. Still more regrettable is it when a controversy on a scientific subject betrays the wish to lower one earnest worker in public esteem in order to extol another. There is in the field ample room for all and no monopoly or "cornering" of any part of it can be for a moment recognized.

These remarks are called forth by the tone of the discussion alluded to above, at least as conducted by some disputants of the one party. It may be that the inevitable inferences which the ordinary reader can scarcely fail to draw from the expressions of Prof. Wright's assailants are unintended and unjustified. In that case we can only regret that the writers were not more guarded and more temperate in their language for they have exposed themselves to the severe counter-criticism that their objections have rather the authoritative tone of the ecclesiastical controversialist than that of the scientific investigator.

The chapter of Prof. Wright's book which has called forth the severest remarks is that on "The Relics of Man in the Glacial Era." In this Prof. W. briefly mentions the leading instances that have been adduced of the discovery of human works and remains under strata considered of glacial date or in others ascribed to pre-glacial time.

Omitting the instances quoted from Europe to which no objection has been raised those from America are as follows: The well known "finds" of Dr. Abbott at Trenton, N. J., those of Dr. Metz at Madisonville, O., that of Mr. Cresson, in Jackson county, Ind., and of Mr. Mills at Newcomerstown, O., those of Prof. Winchell and Miss Babbitt of Minnesota, the second find of Mr. Cresson at Claymont, Del., the various discoveries on the Pacific coast made known by Prof. Whitney and Mr. Becker, and lastly the now familiar "Nampa Image" from Idaho.

In setting forth these examples Prof. W. of course relies on the evidence presented by their different authors. No other course was open to him. They are quoted with the caution due to their rarity and significance though the cumulative value of the evidence is commented on. The wholesale rejection of this evidence by some of Prof. W.'s critics means the condemnation of witnesses such as Whitney, Abbott, Metz, Cresson, Winchell (N. H.), Upham, Shaler, etc. This should not be lightly done. The testimony even of careful ordinary observers to facts may need confirmation but must not be contemptuously waived aside.

Derogatory remarks as to competency are quite out of place in connection with such names as those above quoted.

We do not propose here and now to enter on a discussion of glacial man. It would exceed our due limits in an article of this kind. We will at present content ourselves with a protest against the tone adopted by some of the critics and the air of assumption and of superiority that pervades their remarks. Both are eminently unbecoming to scientific literature and derogatory of the dignity of science. We may add that they are in striking contrast to the modesty and caution of the replies.

To pick out what is admittedly and necessarily the weakest part of a book for destructive criticism, omitting all its excellencies, is hardly the work of a reviewer while the insinuation of disingenuousness is equally unworthy of a critic. The scope and tone of some of the articles must, whether justly or unjustly we cannot say, awaken in the minds of many readers the suspicion of an ulterior or personal motive. This is deeply to be regretted.

We will add but a few words. Granting that all these quoted cases fail, as of course they do, to *prove* the presence of man in America during the Ice-Age they must be admitted by impartial judges to tend in that direction; for it is impossible to admit that they are all and altogether fallacious. Only by the accumulation of such proof can we expect to establish the position. Absolutely conclusive single instances are not probable. Why then should so great anxiety be manifested to break down the testimony in their favor? No reasonable doubt can now be entertained that man was coeval with the ice in some part of the world and no evolutionist can well afford to date his first appearance later than the Ice-Age. It is somewhat difficult therefore to discover the motive that has led to so violent an attack on a work which after all merely summarizes with caution the evidence as it stands and draws a qualified conclusion from it. Strange indeed is it to see the theologian in the van of the evolutionary army with the geologist and the archæologist lingering in the rear.

In the March number of the GEOLOGIST we shall gather together the opinions of a number of American geologists so as to present a sort of symposium on this subject.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Final Geological Report of the Artesian and Underground Investigation, between the ninety-seventh meridian of longitude and the foot-hills of the Rocky Mountains. To the Secretary of Agriculture, made by PROF. ROBT. HAY, F. G. S. A., Part Third, Washington, 1892.

The above titled report so far as relates to Texas, is based upon the observations of Mr. Hay during a brief railroad trip through the Panhandle of Texas in company with Prof. Robt. T. Hill, who signs himself Assistant Geologist for Texas, New Mexico and Indian Territory.

Such reports, to be of importance, must be based upon careful observations and correct determinations of the geological structure of the area covered by the report; and unless such is the case, the guesses of one man as to its artesian water possibilities, will be as good as those of another. Not only is it necessary to have a knowledge of the geology of the country, but the course and rate of the dip of the strata and of the surface must be correctly determined, if areas are to be pointed out where artesian water will flow. If an observer makes a mistake in regard to a receiving area, that mistake will follow his conclusions throughout the entire area under which the strata are supposed to lie. If there be a mistake as to the course and rate of the dip of the water bearing beds, the result will be mistakes in the fact and extent of the area of possible flowing wells.

It is utterly impossible for a person to study the geology of a country by traveling over it in a railway train and simply stopping off at some of the principal stations; and reports based upon such observations are more than liable to be erroneous. It is not the amount of travel that a person accomplishes over a district that makes him a geologist, or that enables him to correctly determine its geological conditions. That the geology of a country cannot be studied in such manner is well illustrated in the report under review.

Mr. Hay came to the Panhandle of Texas, and made recconnoisances with Prof. Hill, as he tells us, and with no more information than he obtained from such hasty examination, writes his report of that part of the district. The mistakes he has made in the small space allotted to Texas are of such a character that one would think that he had never been in the district at all.

Would a man who knew anything, from personal observations or otherwise, about the head of Red river of Texas ever make it flow through Canon Blanco, when Blanco is the canon through which the Salt fork of the Brazos flows? Palo Duro is the canon of Red river.

On page 13 of the report, in speaking of the mountain source of

rivers, after having mentioned other localities outside of Texas, he says, "So the Pecos and Red rivers are cut off from montanal connection by the higher valleys of the Canadian and Rio Grande. Other rivers of Texas are seen to have similar origin, though some have what might be called a mountain supply, as they rise near the isolated mountain groups of the Sierra Blanca and Wichita mountains."

The question would naturally arise, does a man know enough about a country to venture to write a report about its artesian water supply, who makes such glaring mistakes as to put the Rio Grande between the mountains and the Pecos river; or who will have any of the rivers of Texas getting their supply of water from the Wichita mountains, which are on the north side of Red river, and east of the east line of the Texas Panhandle; or who will have any river getting a supply from Sierra Blanca when there is no water there for any purpose, the nearest supply being the Rio Grande? Even the party of the State Geological Survey had to be supplied with water left for them by railroad officials along the line of the railroad during the time the party was working in that district.

Mr. Hay also makes the Brazos river a tributary of the "Father of waters." (See page 15.)

It will be found upon examination, that he knows as little of the geology of North Texas as he does of its physical geography.

He begins by saying (page 9): The strata in the earth's crust that it is necessary to know the names of in this investigation are arranged as groups and sub-groups as follows:

Cenozoic:
  Quarternary or Pleistocene:
    Drift.
    Loess.
Tertiary:
    Pliocene.
    Miocene.
    Eocene.
Mesozoic:
  Cretaceous:
    Laramie.
    Montana.
    Colorado.
    Dakota.
Mesozoic—Continued.
    Trinity.
    Jurassic.
    Triassic.
Paleozoic:
    Carboniferous including Permian.
    Devonian.
    Silurian.
    Cambrian.
Archaean:
    Schists.
    Gneiss.
    Granite.

The arrangement of the table as printed would lead to the inference that he knew nothing of the recognized value of the term group, since in it he makes the Tertiary system of equal value with the Cenozoic group of which it forms a part and puts the Trinity division of the Cretaceous system on equality with such systems as the Cretaceous, Jurassic and Triassic.

The further statement on the same page that "the left hand column has its terms based upon the remains of life, fossils found in the rocks," is simply ridiculous, if originally intended to apply to this table.

His whole treatment of it is such as to lead only to confusion, and the use of these terms in such an indiscriminate manner at least suggests the inability of the author to give exact information upon the subject of which he is writing.

On page 20, he makes this statement: "South of the Arkansas the Dakota sandstones and shales are immediately subjacent to the grit and further south still the Jurassic [or the Neocomian] is in that position, while further east of the Jurassic is mostly missing as in the valleys of the Canadian and Red rivers east of the one-hundredth meridian and the Triassic red beds are found there immediately under the Tertiaries."

Does he, or his editor for him, intend, by including the words "or the Neocomian" in brackets, just after the word "Jurassic" to give us to understand he puts the Jurassic in the Neocomian, or is he undecided to which it belongs? It would puzzle him very much to find a place in Texas east of the one-hundredth meridian where the Jurassic was not entirely missing.

He continues, "On the high plain of West Texas—The Llano Estacado—the Red river has cut a gash 1,000 feet deep which shows this descending order of formations:

Plains Marl.
Tertiary Grit.
Jurassic.
Triassic."

We cannot exactly locate the place of his section, as the deepest place on the Palo Duro canon is only nine hundred feet, and decreases from that to four hundred, so the place cannot be determined by the depth given. Nor is there any such succession of strata as he mentions, to be found anywhere along the canon of Red river. I have gone up the canon from mouth to head and made many dozens of sections and many measurements of the depth of the canon, and I can say with absolutely certainty that there is no such succession of strata to be found there.

At the mouth of the canon there is a section showing two hundred feet of Tertiary, three hundred feet of Triassic, and the other four hundred feet of Permian. There is not a foot of Jurassic in the canon; and for that matter in that part of the state.

The age of the Trinity sands is unsettled, or was at the time when this report was written, and it might have been thought that he was calling the Trinity sands "Jurassic," but he has taken care that we shall not so understand him, for in the section he gave us he mentions both the Trinity sands and the Jurassic (see page 9 of his report). But admitting that in his cumbersome and random way of expressing himself he might have meant the Trinity sands when he said in the paragraph last quoted, Jurassic, [or the Neocomian] it would leave the matter in no better condition, for there is not a single outcrop of the Trinity sands from the Double Mountain fork

of the Brazos river northward along the eastern escarpment of the Staked plains to their northeast corner, nor along the north escarpment of the Plains westward to the west line of Texas, nor along any of the canons of the upper Red river. The question therefore naturally suggests itself, was Mr. Hay ever at the "gash" of which he speaks, and if so, does he know Jurassic when he sees it? He certainly did not get his information from Prof. Hill, for the latter says in his report in one place, that the plains material in that part of the state rests on the Triassic. He is probably aware of the fact that nearly every geologist, since Marcou first determined it in 1853, has put the lower red beds of Texas in the Permian.

He does not attempt to tell us whether there is an artesian water area in the Panhandle of Texas or not, but it is probable that he does not think there is, as he has cut off that region from mountain supply by having the Rio Grande run between the Pecos and the mountains.

He says on page 33, in speaking of the underflow of water, that "Mr. Hill has accounted for the source of water of the great springs of Texas without recourse to the distant mountains." That is only correct in part, for there are numerous large springs in Texas that can only be accounted for by having "recourse to the distant mountains." Such are the large springs in Lampasas and San Saba counties whose water reaches the surface through the Carboniferous and Silurian strata. Mr. Hill mentioned Lampasas springs but did not attempt to give the probable source of the water, nor does he attempt to account for the origin of the water of any of the large springs of San Saba county.

Opposite page 37 he gives Section XX showing a synclinal or trough, in which are the outlines of an ideal artesian basin, as though such a condition existed. He says, "the conditions as shown by figure XX are almost those that would be found by a carefully made diagram of the actual levels and stratifications from the Black Hills to the James river, and across the region of the Fort Worth-Waco basin of Texas, as well as other regions of approved artesian water supply."

Instead of the Fort Worth-Waco area being a basin, it is simply a series of water bearing strata that have a regular dip from the northwest, and is not a basin in any sense of the word. Had Mr. Hay known anything about the matter, he would never have said it was similar to his ideal basin. He seems to have read Hill's report to very little advantage.

In Mr. Hay's part of the report, there are in isolated paragraphs less than three pages altogether on the Texas area, and the reference is rather incidental than otherwise, and yet there is in these references such an array of ignorance of the matter of which he is trying to write, whether it be of fact or of conclusion, that his report for practical purposes is absolutely worthless.

I have called attention to that part of the report that refers to Texas, for the reason that I am personally familiar with a large part of its territory and can speak from personal knowledge. If the rest of

Mr. Hay's report is as full of mistakes as is that which refers to Texas, it might with propriety be called, "A Comedy of Errors," were it not for the fact that it is too flat to be comical.

The Second Volume of the Final Report of the Second Geological Survey of Pennsylvania. J. P. Lesley. No geologist has a more intimate or perfect acquaintance with the structure of the Keystone state than he who has been for so many years at the head of the second geological survey. Professor Lesley's connection with the first survey, by Rogers, more than forty years ago and his conduct of the present, together with many years of professional work as a mining and geological engineer, have rendered his knowledge both accurate and minute. It is with pleasure therefore, that we welcome this second volume of his final report summarizing the results obtained in the Systems V to IX in the first survey, or those contained between the Clinton and the Catskill inclusive, of the New York system. The presentation of these results in brief and in a manageable form is as great a boon to geologists as was the publication some years ago of the hand atlas of Pennsylvania, containing small geologically colored maps of every county in the state. It is absolutely impossible that outsiders, to say the least, can grasp the extent and amount of the work unless it is laid before them in some such condensed form as this. Life is too short to allow any one to wade through the hundred and odd volumes already issued by the second survey, in search of what he may never find, and the thanks of all are due to professor Lesley for both his condensations.

Of course the materials have been almost entirely drawn from the separate reports on the counties already issued and mainly from those of professor I. C. White and professor E. W. Claypole which are in great part concerned with the particular formations that form the subjects of this volume.

We do not propose here to criticize the work at any great length or to follow it far into detail. Space will not allow this. Nor do we propose to criticize the plan, which is the same as that of the first volume. The various formations are followed over so much of the state as they cover and the details of their structure set forth. Perhaps in the circumstances no other plan would be any better, if so good.

The labor of thus reducing and condensing the results of the surveyors can only be realized by those who have undertaken similar tasks. Equally surprising is the rapidity with which the second volume has followed the first Let us hope that the health and working strength of the author will at least permit him to complete the third and final volume of his life's work.

Professor Lesley's training naturally inclined him to look most favorably on the structural side of geology and he has often shown undue distrust of the results of palæontology. But in this and the preceding volume he has laid due stress on this part of the subject

and page after page of figures illustrate fairly and often distinctly the fossils of the Pennsylvanian rocks. In this respect the work is far superior to the author's "Dictionary of Fossils."

This report is a perfect mine of valuable information to all who need it, whether geologists or not; while the numerous references enable all who desire them to turn to original authorities for the details.

It is much to be regretted that in most of the state reports the "exigencies of the printing office" so often prevent accurate and careful publication. In thus writing we formulate no new complaint. The fact is notorious and patent. Often detained by the state printer till a more convenient season and then hurried through before the next busy time arrives, there is no opportunity for full correction of errors and for emendation to date of issue. It is consequently not always just to the author to blame him for either kind of fault. The present work is no exception to this rule, and the greater part of the errors and the many misprints may fairly be set down to the causes above mentioned. But there are some for which the author must be accountable. For example, the statement on p. 881 is only partially correct regarding *Psilophyton* and is quite incorrect regarding *Glyptodendron* which was not described by Dawson, or from the Niagara, or from Canada. Numerous inaccuracies also occur in the account of the fossils of the Salina group. On p. 770 *Scaphaspis* is mentioned as a genus. It is the ventral armour of one or other of the genera mentioned in the same sentence. *Plectrodus*, *Sphagodus*, and *Thelodus* (with a *Scaphodus*?) are written down as teeth. A wrong etymology is assigned to *Onchus*. On p. 772.—No fossils have been found in the Bridgeport sandstone Some other similar errors might be noted which one cannot but regret.

For the work as a whole however, we have little but praise and not the least valuable feature is the great abundance of the illustrations.

Sur la présence de fossiles dans le terrain azoïque de Bretagne. By M. CHARLES BARROIS. (Comptes Rendus, T. cxv, No. 6, pp. 326-328, Aug. 8, 1892.) The high authority of M. Barrois (of the geological survey of France and professor of geology in the University of Lille) and his reputation for cautiousness make this communication of especial interest and importance. He has found Radiolarian remains in some of the pre-Cambrain crystallines of France. The beds containing these fossils are thin layers of graphite-bearing quartzyte, which are intimately interbedded with gneisses. The quartzyte consists of quartz grains and graphite plates with some pyrite and feldspars. On microscopic examination of thin sections of the quartzyte small circular or peculiarly outlined bodies were seen among the grains of quartz and graphite. These were found to be the remains of Radiolarians very similar to those occurring in certain graptolite schists of Bretagne. They have been subjected to the examination of M.

Cayeux, who pronounces them to be Radiolarians which belong to the Monosphæridæ, the most primitive forms of the group. These fossils, says M. Barrois, are the most ancient organic remains found in France and probably in the world. The highly metamorphosed character of the quartzyte, in which the fossils are found, and of the associated gneisses is due, at least in part, to intrusions of granite. These rocks belong to a series of more or less crystalline schists which are pre-Cambrian in age (*i. e.* corresponding to our Ontarian), but they overlie the fundamental complex of granites and gneisses (Laurentian).

The Champlain Submergence. By WARREN UPHAM. Bulletin, G. S. A., vol. III, pp. 508-511. Marine fossils in beds overlying the glacial drift show that the northeastern part of North America stood lower than now during the Champlain epoch, or time of departure of the last ice-sheet. The depression was little at Boston, increasing to about 300 feet along the coast of Maine and southern New Brunswick, 520 feet at Montreal, 300 to 500 feet southwest of James bay, and 1,000 to 2,000 feet in northern Greenland and Grinnell land. From the Champlain submergence the land was raised somewhat higher than now, and its latest movement from New Jersey to southern Greenland has been a moderate depression, attested in many places by stumps of forests, rooted where they grew, and by peat beds now submerged by the sea. The vertical extent of this recent sinking has been at least 80 feet at the head of the bay of Fundy.

Similarly in Scandinavia the observations of Baron de Geer prove for that country a depression with maximum of probably 1,000 feet near the center of the peninsula, while the land was enveloped by the ice-sheet: a postglacial re-elevation to a hight in some tracts of about 100 feet above that of the present time; a second subsidence of the country, less than the first; and a second uplifting, which is now slowly in progress. The author concludes that "so extensive agreement on opposite sides of the Atlantic in the oscillations of the land while it was ice-covered, and since the departure of the ice-sheets, has probably resulted from similar causes, namely, the pressure of the ice-weight and the resilience of the earth's crust when it was unburdened. The restoration of isostatic equilibrium in each country is attended by minor oscillations, the conditions requisite for repose being over-passed by the early re-elevation of outer portions of each of these great glaciated areas."

Note on the Middleton formation of Tennessee, Mississippi, and Alabama. By JAMES M. SAFFORD. Bulletin, G. S. A., vol. III, pp. 511, 512. This formation, named with the concurrence of Profs. E. W. Hilgard and E. A. Smith, comprises the lowest Eocene beds in the states mentioned. It is named for the town of Middleton, on the Memphis and Charleston railroad in Hardeman county, Tennessee.

Phylogeny of the lingulates. MME. PAVLOW, (Bull. Soc. Impe. d. Nat. Moscou, 6, p. 146, 3 plates), in her present paper, seems to have fallen into error, especially in her attempt to trace the living Malayan Rhinoceros down through *R. karnuliensis* and *R. deccanensis* of the Pleistocene of the Indian peninsula. These latter were devoid of cutting teeth. A table is given in which it appears that the derivation of the Rhinoceros is from the "*Systemodon*" of North America. However, while there are some errors, this writer's memoirs furnish food for some very deep thought, and many of her studies are of much value.

"*On a series of Peculiar Schists near Salida, Col.*" MR. WHITMAN CROSS, in his paper before the Col. Sci. Soc., Jan. 2, 1893, gives some interesting facts regarding the crystalline schists of the Rocky mountains, and announces this as a preliminary paper. He first describes the geology of the region and points out the fact that a previous study of the region by Dr. F. M. Endlich is almost entirely incorrect, and this is well supported by Mr. Cross' observations. The stratigraphy and general characters of the schistose series are then described and he finds that in passing northward the schistose characters become more marked. The chlorite schist at this locality has furnished the enormous dodecahedral garnets now so common in collections. Then follows a brief discussion on the origin of the schists, and the relationships of the series, in which he announces that metamorphosed sedimentary rocks do not exist among the crystalline schists of Colorado; and finally concludes that the schists and massive rocks of Salida "represent a great series of surface lavas erupted in Algonkian time." They thus repeat, apparently, the eruptive phases of the Nipigon series of the lake Superior region, and fall into the same stratigraphic position.

Palæaster eucharis Hall. By A. H. COLE. Bulletin, G. S. A., vol. III, pp. 512-514, with plate. This species, first described twenty-five years ago, is now more accurately known by a very finely preserved specimen found in July, 1891, in the Hamilton shales of the quarry belonging to Colgate university at Hamilton, N. Y.

Grahamite in Texas. MR. E. T. DUMBLE (Am. Inst. M. E's, Oct. 1892) describes some occurrences of this carbon. There are two localities, both in the Tertiary; the first at Webb Bluff, Webb Co., where it occurs in the Eocene, associated with gypsum and efflorescent sulphur; the second locality, in Fayette Co., where the grahamite occurs on Buckner's and O'Quinn's creeks, in connection with brown-coal. Analyses are given, which indicate a very high percentage of sulphur.

CORRESPONDENCE.

SOME OF PROF. SALISBURY'S CRITICISMS ON "MAN AND THE GLACIAL PERIOD."—I am indebted to Prof. Salisbury for kindly pointing out several errors of more or less importance in my recent volume on "Man and the Glacial Period;" but so many of his criticisms are merely confident assertions of unproven points, that they should not all be allowed to pass without some notice. I will, however, limit myself to traversing only a few of his misplaced criticisms.

1st. He says (p. 14) that I should have emphasized more than I did, the separation, indicated upon my map west of Pennsylvania, between the extreme border of the glacial drift and the morainic accumulations, which he declares to be a most significant point. On the contrary, I maintain that it is becoming more and more evident that Prof. Salisbury enormously exaggerates the importance of that distinction. Now that Mr. Leverett has brought the moraines of Ohio close down to my border line, and that we have given closer attention to the so-called "fringe" or "attenuated border," in eastern Pennsylvania and in New Jersey, it is becoming more and more evident that the fringe is but an appendage of the terminal moraine. The fundamental errors of Prof. Salisbury's report upon "The Extra-Morainic Glacial Drift of New Jersey" (see An. Rep. for 1891, pp. 102, 108), were pretty clearly shown in the article by Prof. A. A. Wright in the AMERICAN GEOLOGIST for October, pp. 207-216. These will appear in still clearer light upon the full publication of my own observations in connection with my associate.

Prof. Salisbury, in discussing the extra-morainic drift in New Jersey, has, beyond all question, failed to distinguish between the effects of the secular disintegration of gneissoid rocks and the post-glacial oxidation of morainic material, and, so far as I could find, he has failed to make any systematic attempt to determine the limits of the attenuated border of glacial deposits in the state. Following out the imperfectly formed plans of Prof. Lewis and myself, I have already determined this nearly half way across the state, and can speak with great positiveness as to the fact that the problem in New Jersey is not essentially different from the problem in Ohio, and that the great significance which Prof. Salisbury attributes to it in proof of his theory of two glacial epochs is without foundation.

2d. In my paragraphs upon drumlins, alluded to by Prof. Salisbury, I am expressly giving "the plausible explanation" of them presented by Prof. Davis. The view which Prof. Salisbury combats is one to which Prof. Davis gives his positive assent in his concluding sentence: "Under unending glaciation, the whole surface must be rubbed down smooth." It would seem scarcely necessary to explain to Mr. Salisbury that the processes of accumulation and of degradation by both rivers and glaciers may be going on continuously in closely adjacent areas. Which shall predominate at any point depends largely upon the amount of material at command of the moving current.

3d. Prof. Salisbury's paragraph concerning my position upon the unity of the glacial epoch is ill considered and misleading. He says that I should have indicated that my view is that of the minority. I am at a loss to know how I could have expressed that idea more clearly than I have done on page 110, in introducing my formal discussion of the subject, where all I claim is that, notwithstanding the position of Pres. Chamberlin and many others, the theory of the unity of the glacial epoch "is capable of being maintained without forfeiting one's rights to the respect of his fellow geologists." As to what is the actual trend of sentiment, there is, however, much room for difference of opinion. One need not be ashamed to be in company with such authorities upon glacial subjects as Dana, Hitchcock, Upham, Falsan, Prestwich, Kendall, Lamplugh, Hughes, Holtz, Credner, Diener, Nikitin, and numerous others. It is significant that Nikitin, at the head of the geological survey of Russia, has just published a long paper in which he maintains that the glacial deposits of that region give no evidence of more than one epoch.

4th. Prof. Salisbury says that I maintain that oceanic waters "probably" reached southern Illinois and Indiana. What I said was that "it is perhaps necessary to suppose." If Prof. Salisbury thinks that means probably, he is welcome to the opinion.

5th. I will say but a few words concerning the Cincinnati ice-dam. I have taken pains to give my readers the information that upon this point there are differences of opinion, and that Prof. Chamberlin is opposed to my view.

Whether Prof. Chamberlin's strictures upon this theory, in his introduction to my report upon the subject, in Bulletin 58 of the United States Geological Survey, contain the final word upon the subject may be a fair question of doubt. At any rate, I have not been ashamed to have the two documents circulated together; for, to mention only two points in his introduction, we find Prof. Chamberlin admitting that "the ice-sheet probably pushed across the river, and landed the bouldery drift south of it essentially in its present position." Now, the Canadian boulder, of which I give an illustration on page 63, is three feet and a half in diameter upon a hight of land fully six miles south of the river at its nearest point. How Prof. Chamberlin could maintain, as he does, p. 18, that the ponded water of the upper Ohio would probably lift "bodily" the mass of ice which carried these glacial deposits so far south of the river is more than I could ever understand, for the specific gravity of ice is such that seven or eight feet will remain under water when one is above. To have carried the glacial material into Kentucky as far as has been done by so thin a piece of ice that 500 feet of water would float it, is well-nigh an absurdity.

As to other portions of his introduction, it is sufficient to say that doubtless many things were at first attributed to this probable ice-dam which must be explained by other causes. But that Prof. Chamberlin has explained *all* the facts away is by no means so clear. In

the first place, it should be noted, that the upper Ohio and its tributaries occupy a vast area, and present a very complicated set of phenomena. Toward the exploration of this region and the untangling of these phenomena Prof. Chamberlin tells us (p. 22) that he spent twenty days. But, secondly, to say nothing of the far longer time which I have spent in the study of the phenomena, Prof. I. C. White, a geologist of the highest ability, who has spent his life in that region, and surveyed it most carefully, still maintains with great confidence that Prof. Chamberlin's explanation is utterly inadequate to account for all the facts. It should be added, however, that Prof. White's own mind has been wavering between the explanation afforded by the Cincinnati ice-dam (to which he at first gave his unqualified adhesion), and that afforded by a supposed extensive subsidence during the Champlain epoch (see Bull. of Geol. Soc. of America, vol. I, pp. 477-479).

In view of these facts, and with additional evidence which I have recently collected, the Cincinnati ice-dam is an hypothesis which still gives fair promise of solving many of the geological anomalies in the Quaternary deposits of the upper Ohio valley.

6th. I am sorry to have misrepresented Prof. Chamberlin's position with reference to the wanderings of the north pole; but in this I must in part lay the blame upon the AMERICAN GEOLOGIST, of which Prof. Salisbury was at the time editor, which thus reported Prof. Chamberlin's paper: "Prof. T. C. Chamberlin, in the afternoon, summarized the standing of several of the theories which have been suggested to explain the occurrence of the Ice age. After stating that the hypothesis of Croll now fails to account for the phenomena, at least on this continent, he hastily sketched the theory of elevation as the cause of the cold, and offered as in his view most probable a change of the axis of the earth's rotation" (see AMERICAN GEOLOGIST, Sept., 1891, p. 195). This was repeated in a fuller report in the October number, p. 237.

7th. Finally, in respect to the occurrence in America of palæolithic implements in undisturbed gravel strata of glacial age, it is proper that I should here give a more detailed statement than I have elsewhere done. At the outset I may premise that the apparent monopoly of this evidence by Prof. Putnam and his associates in the Peabody Museum at Cambridge, Mass., has come about by a legitimate and natural process, which at the same time has probably interfered, to a considerable extent, with the general spread of the specific information in hand. Early in the investigations of Dr. Abbott, at Trenton, N. J., professor Putnam, who had lately become curator of the museum, with its large fund for prosecuting investigations, satisfied himself of the genuineness of Dr. Abbott's discoveries, and at once retained him as an assistant in the work of the museum; thus diverting to Cambridge all his discoveries at Trenton. Living on the ground during long-continued and extensive excavations made by the railroad, Dr. Abbott's opportunities were exceptionally favor-

able for making discoveries, and hence his own prominence in the whole matter.

It is important, however, to note that before taking up with Dr. Abbott's work, professor Putnam took ample pains to satisfy himself of its character and correctness. In 1878 Prof J. D. Whitney visited Trenton in company with Mr. Carr, assistant curator of the museum. In the twelfth annual report Mr. Carr writes: "We were fortunate enough to find several of these implements in place. Prof. Whitney has no doubt as to the antiquity of the drift, and we are both in full accord with Dr. Abbott as to the artificial character of many of these implements." In reporting further upon this instance at the meeting of the Boston Society of Natural History, on January 19, 1881, Mr. Carr states that the circumstances were such that "it [*i. e.*, one of the particular implements] must have been deposited at the time the containing bed was laid down." In 1879, and again in 1880 professor Putnam spent some time at Trenton, and succeeded in finding with his own hands "five unquestionable palæolithic implements from the gravel, at various depths and at different points." One of these was four feet below the surface soil and one foot in from the perpendicular face which had just been exposed, and where it was clear that the gravel had not been disturbed. A second one was eight feet below the surface. (Proc. Boston Soc. of Nat. Hist. for Jan. 19, 1881.)

Up to 1881 Dr. Abbott had reported sixty implements of palæolithic type from recorded depths in the gravel. In several instances the implements were found in railroad excavations far back from the river front, at a depth of from ten to sixteen feet from the surface, where there could have been no "creep" of the strata, and where it is impossible to believe that there could have been previously any excavations.

As confirming the entire trustworthiness of Dr. Abbott's observations, it is to be noted that, with a single exception, all the implements reported below the loam which constitutes the surface soil, are of argillite, while those upon the surface, which are innumerable, are chiefly of a different type, made from flint and jasper, or of other material of relative character. Another fact, which has always had great weight in my own mind, is one mentioned by the late professor Carvill Lewis, in his chapter upon the subject at the end of Dr. Abbott's volume on "Primitive Industry." I have the more reason to feel the force of his conclusions, because the proof-sheets passed through Lewis' hands at the time we were together conducting the survey in Pennsylvania, soon after we had visited the deposits in question. The fact was this: professor Lewis had been at work for a considerable time in classifying and mapping the gravels in the Delaware valley, being all the time in ignorance of Dr. Abbott's work until his own results were definitely formulated. But after he had accurately determined the boundary between the glacial gravels and the far older gravels which surround them and spread over a considerable portion of the territory beyond, he found that the localities where

Mr. Carr, professor Putnam, and Dr. Abbott had reported finding their implements in undisturbed gravel, all fell within the limits of the glacial gravels, and had in no case been put outside of those limits. Now, Dr. Abbott's house is situated upon the older gravel; but at the time of most of his discoveries he had not learned to distinguish the one gravel from the other. If these implements are all from the surface and had been commingled with lower strata by excavations, landslides, or windfalls, there is no reason why they should not have been found in the older gravels as well as in those of glacial age. There is here a coincidence which is strongly confirmatory of the correctness of our conclusion that there is no mistake in believing that the implements were originally deposited with the gravel where they were found.

Mr. Holmes has not yet published his observations, but I know, in general, what they are. He has watched the digging of an extensive sewer, in Trenton, and has not himself found any implements; while many other persons have looked, more or less, for implements *in situ* and have not found them. But negative evidence of this sort will have slight weight in the presence of the abundant and minute positive evidence adduced, especially in view of the varying experience which the same individual often has in such discoveries. For example, professor Putnam found three of his implements in place in a single day. "A long-continued search on several following days failed of success in finding other specimens in place, although several were obtained from the talus." Furthermore, the general public has an exaggerated estimate of the frequency with which implements occur in these great gravel deposits. Even at Amiens, France, the casual visitor stands small chance of finding an implement in place; while the practice there of sifting the gravel enables the workmen to find everything there is. The conditions under which the work is prosecuted at Trenton are not at all favorable for discovering everything which the gravel contains.

As to Mr. Holmes' theory that all these implements are "rejects" I think the error would be at once manifest to any one, upon inspecting the large collection at the Peabody Museum. But even if they are "rejects," if they are found in undisturbed strata of glacial age they are as good evidence of glacial man as perfect implements would be. But the implement discovered at Newcomerstown, Ohio (figured at p. 252 of my book, and of which I have given a full account in the proceedings of the Western Reserve Historical Society of Cleveland, Ohio), has been seen by Mr. Holmes and pronounced as complete and perfect as could be desired; and this was found fifteen feet below the surface, where a railroad excavation was working into a glacial terrace precisely like that at Trenton, and where there could have been no previous disturbance of the soil. The discovery by Dr. Metz (another of Prof. Putnam's most competent assistants), of a perfectly formed implement in the glacial terrace on the Little Miami, at Madisonville, Ohio, is another well-established confirmation of the exist-

ence of glacial man in America. The existence of glacial man in America would seem, therefore, to be proved beyond "reasonable doubt." Those who are expressing doubts are speaking, for the most part, in ignorance of evidence which has long been before the public. Probably, in my book, I should have had this class of doubters more in mind and have stated the evidence more fully. But there is a limit to what can be put into one small volume.

January 9th, 1893. G. FREDERICK WRIGHT.

A NEW LOCALITY FOR MILLERITE. For a number of years there have been noted occasionally in "geode collections" examined from different parts of Lee county in southeastern Iowa certain specimens containing clear calcite crystals, traversed in different directions by minute, yellowish filaments, after the manner of the familiar *fleches d'amour*—the rutile needles in quartz. The "geodes" of the region are from the Keokuk limestone of the lower Carboniferous, or Mississippian, series. As is well known they are spherical concretions of silicious matter, sometimes solid, often hollow and lined with crystals of quartz or calcite—veritable crystal grottoes in miniature. In size they vary from half an inch to two feet in diameter. Not unfrequently various metallic minerals in more or less well bounded crystallographic forms stud the outer surface of the calcites and quartzes. Among these may be mentioned sphalerite, chalcopyrite and iron pyrites.

Recently in opening a large quarry in the vicinity of Keokuk in the compact Keokuk limestone some feet below the regular "geode bed," numerous cavities were encountered varying from several inches up to perhaps twenty inches. These hollows have large thickly set rhombohedrons of calcite jutting out towards the center. The faces are brightly polished and the edges are sharply cut. In some of the calcites have been found most beautiful tufts of closely arranged brass-yellow needles of millerite pointing from the center of attachment in all directions to a distance of one-half to two and one-half inches. In some of the examples the tufts are made up of hundreds of filaments, often so close together that the needles of different bunches are interwoven closely, forming a dense, matted mass. Often a large, perfectly transparent calcite has a tuft of long millerites completely inclosed in it; or part of the tuft may be imbedded in the lime crystal, the extremities of the needles left projecting outside.

This is the first time that any of the nickel-bearing minerals have been reported from Iowa; and the noting of the sulphide of the metal is therefore of considerable interest. The Keokuk occurrences are believed to be the most beautiful ever found in this country, if not in the world.

Mr. C. A. Flannery of Keokuk has very lately come across another "pocket" of similar geodes containing millerite. One specimen of calcite covered thickly with needles of the nickel sulphide weighed over fifty pounds. CHARLES R. KEYES.

Des Moines, Iowa, Dec. 6, 1892.

THE TOPOGRAPHICAL WORK OF THE UNITED STATES GEOLOGICAL SURVEY. Your rejoinder to my letter on the topographical work of the U. S. Geological Survey, in the January number of the GEOLOGIST leaves little occasion for reply, since either implicitly or explicitly it admits nearly all of its corrections. There remain, however, one or two points concerning which a little further discussion may, in my judgment, be had with profit.

My statement respecting the interpretation of the law defining the area of work of the Geological Survey was, that it was amended "after full discussion in Congress." This is correctly quoted by you and amended to read "after full discussion in *a Committee of the House*." If you will consult the *Congressional Record*, Vol. IX, pp. 2420-2424; Vol. X, pp. 4067-4274; Vol. XI, pp. 121, 131, 779, 2110, 2112, 2349; Vol. XIII, pp. 5923-5930, you will see that I wrote from full information and will, I am sure, withdraw your correction of my statement.

The unqualified statement that "the *Coast and Geodetic Survey was working, at that very time, under a far-reaching scheme which had been in operation for several years, under authority of law, on a general map of the United States of a character nearly identical with that now being executed by the United States Geological Survey*," is interesting, if true, but I fail to find any demonstration of it in your reply. That the Coast and Geodetic Survey might have been willing to undertake the work, may perhaps be conceded, but did it undertake it? True, it was engaged in geodetic triangulation in various parts of the interior. That is well known, but geodetic triangulation is not map-making, nor is it necessarily a prelude to map-making. The only act of the Coast Survey, known to me, suggesting an intention to map the interior was the employment of Mr. H. F. Walling during the years 1881-2, to compile railroad and other map material and to supplement this compilation where needful by surveys. In this way some 1,600 square miles in northern Maryland and West Virginia were mapped, on a field scale of one mile to one inch in one hundred foot contours. The work in North Carolina and adjoining states to which you refer was purely a compilation, on a scale of ten miles to one inch, in hachures. I gravely doubt whether the Coast Survey then regarded or now regards this as a part of a far-reaching scheme for mapping the country.

I must repeat my statement that there has been no duplication of work and no clashing by the two organizations. This, it must be understood, is a question of fact, not of rumor.

Your position, as I understand it, is that, though the maps of the U. S. Geological Survey are "useful and good" yet "Our chief objection is against the agency that is carrying on the work."

This brings into clear relief our chief difference, which may be stated as follows: Is it desirable under present conditions to transfer the work from one bureau to the other? In considering this, it seems hardly worth while to discuss further the question as to which bureau had authority to do the work ten years ago, or whether the Coast and Geodetic Survey was engaged in a far-reaching scheme for going about it at that time. These matters are interesting from a historical standpoint, but are hardly live issues to-day.

Let us consider the present situation for a moment. Our country is to-day almost the only civilized nation which has no good map of its area, and scientific and industrial interests are suffering daily for lack of such a map. Every year that can be saved, in its completion, will save millions to our industries. Time and expense as well as quality should therefore be considered.

The work is to-day, in law and in fact, in the hands of the Geological Survey, is being executed rapidly, efficiently and economically. More than one-fifth of the area of the country, excluding Alaska, has been mapped and those who use the maps agree with you that they are useful and good. The Geological Survey has a large corps of well trained topographers, and is fully equipped for carrying on the work to completion.

All this is certainly favorable to maintaining the status quo.

Now will the quality be improved, the time shortened or the expense lessened by the transfer? And if by transfer, the quality could be improved, will such improvement compensate for the added time and expense attendant upon it?

These are matters about which different opinions may be held, but in considering them let it be steadily remembered that the present status is producing, on the whole, satisfactory results, while the results of a change are uncertain. HENRY GANNETT.

Washington, Jan. 16, 1893.

MR. TAFF'S REPLY TO PROF. HILL. Permit me to correct some erroneous statements in the criticism of my report in your December number. On page No. 394 Mr. Hill says: "Concerning the age of the Trinity beds of my Trinity division for which Mr. Taff, without statement of authority or reason, substitutes the name Bosque." This statement is undoubtedly the result of an oversight or misconception on the part of the critic. I wish to say plainly that I did not apply the name "Bosque" to the Trinity beds as defined by Mr. Hill, moreover, I gave clear reasons why the Trinity and Glen Rose beds, his Trinity division, are inseparable parts of a tripartite division.* Why I did not apply the name Trinity to this clearly defined division is evident. The name Trinity division was given first to the Trinity sand bed by Mr. Hill.† Later this Trinity division was thrown with the Glen Rose limestone for the reason that "I have discovered," he says, "that the beds described under this general term (Trinity or Basal division) really include two stratigraphic subdivisions separated by distinct lithologic and paleontologic characteristics,"‡ a peculiar reason why two beds should be classed under a single division. To augment further the confusion by applying the name Trinity to my new tripartite division when one of those subdivisions had been properly named "Trinity" would be altogether unreasonable. The rocks of the Bosque division are most beautifully developed and ex-

*Geol Survey of Texas, Third Annual Report, 1891, pp. Nos 300, 306, 307, 311, 312, 323 and 324. See also details of sections of the Bosque division.

†Geol. Survey of Arkansas, 1888, Vol. II, p. 116, et seq., Geol. Survey of Texas, Bulletin No. 4, 1889, p. xv, and First Annual Report, 1889, p. No. 118.

‡The Comanche Series of the Texas-Arkansas Region, Bulletin Geol. Society of America, p. 505.

posed along the Bosque river for a distance of more than fifty miles from its source. At no other locality has nature so well arranged and exposed these rocks for study, hence I gave the name Bosque division.

Concerning the section of the Comanche series on page 395: My report covers the ground which has been gone over by Mr. Hill and others, but it is based entirely upon the observations of myself and my assistant, Mr. Leverett, with the exception of the description of the Comanche Peak section (Third Annual Report. Geol. Survey of Texas, 1891, p. 307) for which due credit is given Messrs. J. S. Stone and W. T. Davidson. None of Mr. Hill's notes have ever been accessible to me, had I wished to use them.

It is simply astonishing that Mr. Hill should place in parallel the order of succession of the rocks of the Comanche series in North Texas as published by me and that as published by himself, and state that they are the same, and claim that I had copied his. I should have thought it more reasonable had he complained that I had mutilated his section. After working three years on the geology of the same formation in a single field and that too where the stratigraphy is as simple as that in the Cretaceous of north Texas, I should be blind indeed, if I had not obtained the correct succession of the rocks. After spending a part of the spring season of 1891 and the whole of the season of 1892 on the Comanche series between Brazos and Red rivers I was surprised to find that Mr. Hill had confounded the Exogyra Arietina bed with the Denison bed See the Comanche Series of the Texas-Arkansas Region, Bulletin Geological Society of America, p. 517), that he had placed the Kiamitia clays in the Washita division without a reason (see Bulletin cited p. 515. By R. T. Hill. For correction see Third Annual Report Geological Survey of Texas, 1891, pp. 275, and 344, by J. A. Taff), and that he should make his Goodland limestone the highest member of the Fredericksburg division when he states, and very truly, that it is, at least, the equivalent of the Comanche Peak beds (See Bulletin cited, pp. No. 514, 515).

The line of demarcation between the Denison and Arietina beds, as shown by the fauna as well as by the strata themselves, was plainly evident to the writer while tracing it and studying the beds continuously through a distance of two hundred miles from Brazos river to Indian Territory line. In any good exposure of the rocks along the south side of the valley of Red river in Grayson and Cooke counties an abundant Fort Worth limestone fauna may be seen in a thin band of limestone between the Arietina and Denison beds. Further south in Denton, Tarrant, and Johnson counties this thin limestone increases, still bearing well defined characteristic Ft. Worth limestone fossils, until there are extensive strata of lime and marl leaving the Denison and Arietina beds widely separated. There is therefore no excuse, on the part of Mr. Hill, for the confusion, after spending the field-season of 1890 in this region. The contacts of all the other beds of the Comanche series have likewise been traced and mapped and the rocks carefully studied between Brazos and Red rivers. If, by this close detailed work, we establish the truth in the geology of the region we are content.

If I may be permitted to refer to such a subject, it behooves Mr. Hill to devote himself more closely to the observation of geological details in the field before trying to establish even much of that which he has already published.

That the name Fredericksburg was first given by Dr. Roemer to the rocks now bearing it, is not only true but is well known by Mr. Hill, as may be seen by reference to the following of his publications: Bull. No. 45 U. S. Geol. Survey, p. 72, and Am. Jour. Sci., April, 1887, p. 298. Dr. Roemer in "Kreidebildungen von Texas," as cited in above Bulletin, refers to the "Fredericksburg strata" and gives a list of fossils many of which are characteristic of the Fredericksburg division as arranged when named by Mr. Hill.

It may be noted that throughout my report little reference was made to the works of geologists in the American Cretaceous, even such valuable works as those of Dr. C. A. White and others, but it must be borne in mind that my paper is simply a report on the stratigraphy of a fragment of a formation covering a limited area in the midst of an extensive field. No claim was made to extensive researches in the paleontology of the field—indeed anything like a connected and systematic study had never been made of the fossils as a whole. Most of the leading forms, however, were known and they were sufficient for stratigraphic correlation. J. A. TAFF.

PERSONAL AND SCIENTIFIC NEWS.

GEOLOGICAL SOCIETY OF AMERICA.—The fifth annual meeting of the Geological Society of America was held in Ottawa, Canada, on December 28th, 29th and 30th, where convenient rooms in the beautiful Parliament buildings had been secured by the local committee. Thirty fellows in all were present.

The society was called to order at ten o'clock on Wednesday morning, by the president, Mr. G. K. Gilbert, after which his excellency, lord Stanley, governor-general of Canada, welcomed the visitors in a neat speech, in which he stated that though politically the United States and Canada might be divided, yet in scientific work the two peoples were in perfect accord. He welcomed them, as the representative of the queen in Canada, and also as a citizen of Ottawa. President Gilbert acknowledged the welcome in a few words.

Mr. Fairchild, the secretary, then presented the annual report of the council, which stated that two meetings of the society had been held during the past year, one at Columbus, Ohio, with an attendance of twenty-three fellows, and the other at Rochester, along with the American Association for the Advancement of Science, when there was an attendance of thirty fellows. They had

lost three members by death, making a total of nine since the society was formed.

The report of Mr. I. C. White, the treasurer, showed that financially the society was in a flourishing condition.

The election of officers for the coming year was then proceeded with, resulting as follows:

President—Sir William Dawson.
First Vice-President—T. C. Chamberlin.
Second Vice-President—J. J. Stevenson.
Secretary—H. L. Fairchild.
Treasurer—I. C. White.
Editor—J. Stanley-Brown.
Members of the Council—E. A. Smith, C. D. Walcott.

Three new fellows were declared elected, viz.: J. F. Whiteaves, Ottawa; H. F. Reid, Cleveland; F. W. Sardeson, Minneapolis.

The remainder of the morning was occupied in reading three obituary notices, viz.: of Dr. T. Sterry Hunt, by professor R. Pumpelly; of Dr. J. S. Newberry, by Prof. J. F. Kemp; and of Dr. J. H. Chapin, by professor W. M. Davis.

Wednesday afternoon was devoted to the reading of the following scientific papers:

A. R. C. SELWYN—On the coals and petroleums of the Crow's Nest pass, Rocky mountains.

Dr. Selwyn spoke at some length on this subject, referring to the enormous quantities of coal which have lately been found in the vicinity of Michel creek, near the Crow's Nest pass. After reviewing his work in this district, he went on to speak of the petroleum of the South Kootenai pass, in which two distinct occurrences were noted. One of these is on Cameron Falls brook where a heavy dark brown oil was found floating on the surface of the stream and in small pools; the other is on Akamina brook, about six miles down the western slope in British Columbia, where the oil was found in a similar manner, but was of much lighter color and gravity. According to Dr. Selwyn, both these oils are from Cambrian rocks.

H. P. BRUMELL—On the geology of natural gas and petroleum in Ontario.

H. P. BRUMELL—Note on the occurrence of Petroleum in Gaspé, Quebec.

Mr. Brumell, in his first paper, treated of the mode of occurrence and distribution of petroleum and natural gas in Ontario, and inferentially brought out points suggesting the non-productive properties of the Trenton formation in the province, while the enormous quantities found in the Medina sandstone make him think that to that formation rather than to the older Trenton must the attention of gas operators be directed. Oil has been found in workable quantities in but one horizon—the Corniferous—though explorations have proved its existence in the Clinton (?) in Essex county, and in the Medina in Welland county.

Mr. Brumell's second paper was merely a note on the mode of occurrence of oil in Gaspé county, Quebec, where desultory work has been carried on for many years, the result being the establishment of the fact that deep-seated oil of superior quality exists, though in what quantity future development alone can tell. The oil is obtained from the limestones underlying the long series of Gaspé sandstones, and is of Lower Devonian or Upper Silurian age.

SIR J. WILLIAM DAWSON—Note on sponges found in the Cambro-Silurian at Little Metis, Canada.

(Read in the absence of the author by Mr. F. D. Adams.)

J. F. WHITEAVES—Notes on the Devonian formation of Manitoba and the N. W. Territories.

Mr. Whiteaves gave a short address in which he discussed the relationship of the fauna of the Devonian formation of northern Manitoba with that of northern Europe. In Manitoba the Stringocephelus zone is remarkably clearly developed, and holds a rich fauna, whereas in the Mackenzie River district, most of the fossils so far collected seem to be from the Cuboides zone.

HENRY M. AMI—Notes on Cambrian fossils from the Selkirks and Rocky Mountain region of Canada.

This paper was based mainly upon a collection of Lower and Middle Cambrian fossils made by the author in the summer of 1891. It contained notes on some eight species of Lower Cambrian (Olenellus zone) fossils from the gray, glossy and calcareous schists and limestones of the entrance to the Selkirks, some two miles west of Donald, British Columbia. The latter part of the paper dealt with the forms met with in the Middle Cambrian of mount Stephen in the Rocky mountains, near Field, B. C., where the terrane is highly fossiliferous. Upwards of twenty species have been recorded from this locality, many of which are very interesting and well-preserved.

HENRY M. AMI—On the Potsdam and Calciferous terranes of the Ottawa Palæozoic basin.

The stratigraphical, lithological and palæontological relations of the Potsdam and Calciferous terranes, as seen and known in the Ottawa Palæozoic basin and elsewhere were discussed in this paper; also the reference of these two terranes to the Cambro-Silurian or Ordovician epoch instead of to the Cambrian epoch, inferred from the internal evidence.

R. D. SALISBURY—Distinct glacial epochs, and the criteria for their recognition.

J. B. TYRRELL—Pleistocene phenomena in the region southeast and east of lake Athabasca, Canada.

The paper was the result of an exploration conducted by the author for the Canadian Geological Survey in the hitherto unexplored region lying southeast of Athabasca lake and north of Churchill. The region is underlain by Archæan gneisses, etc., and Palæozoic sandstones, and has some strongly marked glacial features. The general course of the striation is south-south-westward, but towards the north it turns to the west down the great valley of Athabasca lake, while in the southern portion of the region it turns more directly southward towards the plains. The amount of true subglacial till appeared to be rather small, but great numbers of high drumlins, running with the glacial striæ, were found in the basin of Cree lake and vicinity, and along Black river and around Black lake. These would appear to be formed from material frozen in the ice, and collected in ridges by currents in the glacier. Ridges of stratified sand or kames were also noted.

The watershed north of Caribou river was an extensive sandy plain about the level of some high terraces around Cree lake, and was probably formed when the waters rushed southward from a circumglacial lake. Terraces were also recorded about a hundred feet above Black lake, which is itself three hundred feet above lake Athabasca. Athabasca, Wollaston and Cree lakes lie along the line of contact of the Palæozoic and Archæan rocks.

A great moraine was also noted as forming the watershed between the Saskatchewan and Churchill rivers.

On Wednesday evening Mr. W. J. McGee, of the United States Geological Survey delivered an illustrated lecture on "A Fossil Earthquake," to a large and appreciative audience. About the year 1812 there was a severe earthquake in the Central United States, and as the historical records of this event were not very satisfactory, Mr. McGee spent considerable time going over the ground, and the lecture gave some of the results of his investigations. The center of the earth movement was on the Mississippi river, a short distance below Cairo. Some parts of the land were uplifted while others were depressed, and Reelfoot lake was formed. The lecture was an excellent example of inductive reasoning, clear proofs being given throughout, not only of the occurrence of the earthquake, but of the time at which it took place. In closing the proofs collected by the geologist were compared with contemporary records, and were found to agree perfectly.

A vote of thanks was moved by Sir James Grant and seconded by Mr. sheriff Sweatland, who humorously remarked that if at any time the ground should be too violently shaken in the country south of the international boundary line, the Canadians would always be pleased to offer their American friends a home on the more stable land of the northern part of the continent.

On Thursday morning the society re-assembled in the Railway Committee room of the House of Commons. The report of the committee on photographs was first presented, after which the regular reading and discussion of papers was resumed.

A. P. Low—Notes on the glacial geology of the northeast Territories.

This paper contained observation on the superficial geology in the northern part of the Province of Quebec, and along the Rupert, East Main, Big, Great Whale and Clearwater rivers, all of which empty into Hudson bay on its east side. There are two sets of glacial striæ in this region, the older running from N. 30 E. to S. 30 W., and was evidently the direction of the ice flow during the period of greatest accumulation. The ice at that time pushed in a uniform direction from the highlands of central Labrador over the southern portions of Quebec and Ontario. The later ice markings show that the ice moved down from the interior plateau following the general slope of the country, thus moving directly south in northern Quebec towards the St. Lawrence, and westward towards Hudson bay on that watershed. At this period the glacier formed a terminal moraine, the remains of which form a chain of large islands that extend northward two hundred miles from the south end, up the eastern third of James bay. These islands are wholly composed of unstratified drift. There is a marked absence of the finer material of the drift in the interior of Labrador, the surface being covered with innumerable boulders, often arranged in sharp drumlins. The post-glacial elevation is marked by the limits of stratified sand and clay, and by terraces cut into them. The greatest elevation noted is on the Clearwater river, where these deposits are found 675 feet above the present

SIR J. WILLIAM DAWSON—Note on sponges found in the Cambro-Silurian at Little Metis, Canada.

(Read in the absence of the author by Mr. F. D. Adams.)

J. F. WHITEAVES—Notes on the Devonian formation of Manitoba and the N. W. Territories.

Mr. Whiteaves gave a short address in which he discussed the relationship of the fauna of the Devonian formation of northern Manitoba with that of northern Europe. In Manitoba the Stringocephelus zone is remarkably clearly developed, and holds a rich fauna, whereas in the Mackenzie River district, most of the fossils so far collected seem to be from the Cuboides zone.

HENRY M. AMI—Notes on Cambrian fossils from the Selkirks and Rocky Mountain region of Canada.

This paper was based mainly upon a collection of Lower and Middle Cambrian fossils made by the author in the summer of 1891. It contained notes on some eight species of Lower Cambrian (Olenellus zone) fossils from the gray, glossy and calcareous schists and limestones of the entrance to the Selkirks, some two miles west of Donald, British Columbia. The latter part of the paper dealt with the forms met with in the Middle Cambrian of mount Stephen in the Rocky mountains, near Field, B. C., where the terrane is highly fossiliferous. Upwards of twenty species have been recorded from this locality, many of which are very interesting and well-preserved.

HENRY M. AMI—On the Potsdam and Calciferous terranes of the Ottawa Palæozoic basin.

The stratigraphical, lithological and palæontological relations of the Potsdam and Calciferous terranes, as seen and known in the Ottawa Palæozoic basin and elsewhere were discussed in this paper; also the reference of these two terranes to the Cambro-Silurian or Ordovician epoch instead of to the Cambrian epoch, inferred from the internal evidence.

R. D. SALISBURY—Distinct glacial epochs, and the criteria for their recognition.

J. B. TYRRELL—Pleistocene phenomena in the region southeast and east of lake Athabasca, Canada.

The paper was the result of an exploration conducted by the author for the Canadian Geological Survey in the hitherto unexplored region lying southeast of Athabasca lake and north of Churchill. The region is underlain by Archæan gneisses, etc., and Palæozoic sandstones, and has some strongly marked glacial features. The general course of the striation is south-south-westward, but towards the north it turns to the west down the great valley of Athabasca lake, while in the southern portion of the region it turns more directly southward towards the plains. The amount of true subglacial till appeared to be rather small, but great numbers of high drumlins, running with the glacial striæ, were found in the basin of Cree lake and vicinity, and along Black river and around Black lake. These would appear to be formed from material frozen in the ice, and collected in ridges by currents in the glacier. Ridges of stratified sand or kames were also noted.

The watershed north of Caribou river was an extensive sandy plain about the level of some high terraces around Cree lake, and was probably formed when the waters rushed southward from a circumglacial lake. Terraces were also recorded about a hundred feet above Black lake, which is itself three hundred feet above lake Athabasca. Athabasca, Wollaston and Cree lakes lie along the line of contact of the Palæozoic and Archæan rocks.

A great moraine was also noted as forming the watershed between the Saskatchewan and Churchill rivers.

On Wednesday evening Mr. W. J. McGee, of the United States Geological Survey delivered an illustrated lecture on "A Fossil Earthquake," to a large and appreciative audience. About the year 1812 there was a severe earthquake in the Central United States, and as the historical records of this event were not very satisfactory, Mr. McGee spent considerable time going over the ground, and the lecture gave some of the results of his investigations. The center of the earth movement was on the Mississippi river, a short distance below Cairo. Some parts of the land were uplifted while others were depressed, and Reelfoot lake was formed. The lecture was an excellent example of inductive reasoning, clear proofs being given throughout, not only of the occurrence of the earthquake, but of the time at which it took place. In closing the proofs collected by the geologist were compared with contemporary records, and were found to agree perfectly.

A vote of thanks was moved by Sir James Grant and seconded by Mr. sheriff Sweatland, who humorously remarked that if at any time the ground should be too violently shaken in the country south of the international boundary line, the Canadians would always be pleased to offer their American friends a home on the more stable land of the northern part of the continent.

On Thursday morning the society re-assembled in the Railway Committee room of the House of Commons. The report of the committee on photographs was first presented, after which the regular reading and discussion of papers was resumed.

A. P. Low—Notes on the glacial geology of the northeast Territories.

This paper contained observation on the superficial geology in the northern part of the Province of Quebec, and along the Rupert, East Main, Big, Great Whale and Clearwater rivers, all of which empty into Hudson bay on its east side. There are two sets of glacial striæ in this region, the older running from N. 30° E. to S. 30° W., and was evidently the direction of the ice flow during the period of greatest accumulation. The ice at that time pushed in a uniform direction from the highlands of central Labrador over the southern portions of Quebec and Ontario. The later ice markings show that the ice moved down from the interior plateau following the general slope of the country, thus moving directly south in northern Quebec towards the St. Lawrence, and westward towards Hudson bay on that watershed. At this period the glacier formed a terminal moraine, the remains of which form a chain of large islands that extend northward two hundred miles from the south end, up the eastern third of James bay. These islands are wholly composed of unstratified drift. There is a marked absence of the finer material of the drift in the interior of Labrador, the surface being covered with innumerable boulders, often arranged in sharp drumlins. The post-glacial elevation is marked by the limits of stratified sand and clay, and by terraces cut into them. The greatest elevation noted is on the Clearwater river, where these deposits are found 675 feet above the present

sea level. To the southward on the East Main river similar stratified sands and clays extend continuously inland for one hundred and ten miles, at that distance being about six hundred feet above sea level. Marine fossil shells occur in these beds forty miles inland. It is pointed out that as the elevation along the Atlantic coast of Labrador is only about 200 feet, by the theory, that the greatest elevation occurred in areas of the greatest accumulation, the ice-cap must have been much thicker on the west side of Labrador than on its eastern slope.

ROBERT CHALMERS—The hight of the bay of Fundy coast in the glacial period relative to sea level, as evidenced by marine fossils in the boulder clay at Saint John, New Brunswick.

The fossiliferous boulder-clay referred to by the author, is found on the coast of the bay of Fundy, just west of Saint John harbor, and forms a bank from 40 to 60 feet in hight above sea level. Glacial striæ, varying in direction from S. 2° W. to S. 65° E. (true meridian), occur on the rocks beneath it. The materials of the boulder-clay have all been brought from the north by land-ice. Intercalated in it are seams of stratified clay containing arctic shells (*Yoldia arctica*, &c), in a good state of preservation. These are also found in the unstratified deposits immediately overlying the latter. The author therefore concludes, (1) that the boulder-clay here was produced by successive accretions of material in a zone of oscillation of the ice-front; and, (2) that when the stratified and overlying unstratified portions were deposited the land must have stood 100 to 200 feet lower than at the present day.

W. J. MCGEE—The Pleistocene history of north-eastern Iowa.

WARREN UPHAM—Eskers near Rochester, N. Y.

WARREN UPHAM—Comparison of Pleistocene and present ice sheets.

G. FREDERICK WRIGHT—The post-glacial outlet of the great lakes through lake Nipissing and the Mattawa river.

N. H. DARTON—On certain features in the distribution of the Columbia formation on the middle Atlantic slope.

This paper was a description of relations indicating an interval of erosion between the depositions of the high-level and low-level portions of the formation, beginning in southern Maryland and gradually increasing northward to New Jersey.

GEORGE M. DAWSON—Note on the geology of Middleton Island, Alaska. (Read by R. W. Ells.)

This short paper was devoted principally to the description of a boulder-clay or till from Middleton island, which is found to contain some marine fossils.

ROBERT W. ELLS—On the Laurentian of the Ottawa district.

The author first discussed the early views of Sir Wm. Logan on the structure of the Laurentian, north of the Ottawa, stated in the earlier reports of the Geological Survey, in which the estimated thickness of the rocks of the system, including the Anorthosites, then regarded as an integral part of a gradually ascending series of metamorphic sediments, was stated at 32,750 feet. In this thickness were included at least four distinct bands of limestone, which were supposed to be separated by areas of red orthoclase gneiss, in masses 3,000 to 4,000 feet thick. The recent work in this district has shown that the Anorthosite is an intrusive mass of later date than the gneiss and lime-

stone, as is also the case with other areas, often of considerable size, of augen and syenitic gneiss, pyroxene and quartz-feldspar, formerly also classed as pyroxenic and quartzose gneiss, and regarded as an integral portion of the gneiss and limestone series. In regard to the structure of the calcareous portion the author held that the crystalline limestones should be regarded as the upper member of the series entirely, instead of being placed at widely separated horizons in the orthoclase gneiss, and that there is a gradual passage downward from the calcareous rocks into the gneisses, by the interstratifications in the lower part of thin bands of the latter. The foliation sometimes seen in the syenitic and augen-gneiss, and also in certain portions of the Anorthosite, is supposed to be due to the pressure by which the entire series was thrown into the crumpled state in which it is now found.

The occurrence of economic minerals, such as apatite, graphite, mica and asbestos, is regarded as dependent upon, or influenced by, the intrusions of pyroxene and quartz-feldspar, or other igneous rocks, the apatite being always confined to the pyroxene dykes, except where it occurs in the form of crystals scattered through the limestone mass, or in veins in the pyroxene which traverse that rock. The conclusion was stated that the series in ascending order is gneiss of various kinds, passing upward gradually into limestone, constituting the Laurentian proper, and succeeded upward by the schists of the Hastings series of Vennor, which presumably constitute the lowest member of the Huronian system.

ROBERT BELL—The contact of the Laurentian and Huronian north of lake Huron.

The writer gave a brief sketch of what he has called "The Great Belt of the Huronian rocks of Canada," which runs from lake Superior to lake Mistassini, a distance of 700 miles, following its general course. The so-called "typical Huronian" of lake Huron is only a small section of this belt, and a passing protest was made against the use of this term. The general relation of the Huronian to the Laurentian was next referred to. The question as to the conformity or otherwise of the two systems involves the admission that the Laurentian is an altered sedimentary series. As a rule, the stratification of the latter, whether due to pressure-foliation or to sedimentation was conformable with the aqueous stratification of the Huronian and the few exceptions to this which had been observed in Canada appeared to be all due to faulting.

Many geologists appear to suppose that the bedding of the Huronian rocks along the north shore of lake Huron dips generally at low angles. But even if it did so, this would be merely a local accident of structure and of no significance from a chronological point of view. The dips, however, are not at moderate angles, except in some limited areas. As a rule, they are at very high angles, approaching the vertical—higher indeed than that of the Laurentian gneisses to the eastward.

In tracing the several bands of the Huronian series along the north shore, they are found to strike with great regularity almost due east. But as they approach the contact of the Laurentian they appear to double round the east end of a great syncline, and part of them probably round two or three secondary basins, opposite the eastern part of Grand Manitoulin island.

From the eastern extremity of lake Superior, the Great Belt follows the north shore of lake Huron to Killarney, at the commencement of Georgian bay. Thence its south-eastern border turns inland and runs north-eastward to the Ottawa river. Along this boundary, on leaving lake Huron the stratification on either side is at first parallel or nearly so, but before we have followed the line of contact

twenty miles inland we find the bedding of the Huronian quartzites, &c. (which stands almost on edge), abutting upon the Laurentian, at nearly a right angle. The latter here consists of very regularly stratified gneiss running north-east and dipping uniformly south-eastward at an average angle of 60°.

Near lake Huron a belt of red hornblende-granite intervenes between the gneiss and the quartzite series, but in one part this is separated from the former by a belt of somewhat altered quartzite, so that this granite may be included within the Huronian rather than the Laurentian.

There was clear evidence of a great dislocation between the quartzites on the one hand and the granite and gneiss on the other. The actual contact of the two sets of rocks is plainly seen at many places along the line. It is accompanied by much breaking up of the rocks on either side, forming not only coarse and fine breccias, but also separating masses of the quartzite hundreds of yards in length, from the main body. The latter phenomenon was explained as having been due to thrusts between secondary planes of fracture and the primary one. The Huronian rocks were altered for a few hundred yards inward from the line of dislocation, greywackes being converted into gneiss, silicious flags into mica-schist, etc.

Continuing north-eastward, upon the boundary of the two systems, there was evidence of faulting along their contact where it follows the Wahnapitae river, at the intersection of the Canadian Pacific railway, as described in the report by the author, on the geology of the Sudbury district (1891). Towards lake Temiscaming, on the Ottawa, the two sets of rocks might be conformable. A case of unconformity occurring on the Missinaibi river, north-east of lake Superior, had been mentioned in the author's Geological Survey report for 1875.

Some of the elongated greenstone masses of the lake Huron region might have been originally outflows upon an uneven but approximately horizontal surface. After having been deeply covered by other deposits, the whole series had now been tilted almost on edge and the greenstones appeared as if they might have had an intrusive origin.

The Huronian granites of the region described were, in some cases, at least, altered stratified rocks. Interrupted bands of quartzite and schist had been observed incorporated in the rather coarsely crystalline homogeneous granite.

On the other hand, the Huronian rocks of the north shore of the lake include almost unaltered strata. In a brown sandstone of the series associated with mudstones and dolomites on Aird island, the author had discovered forms resembling fucoids or the trails of annelids, and he exhibited a ripple-marked slab on which these were very well seen.

In the region described, the dependence of the present surface contours and other geographical features upon the nature of the fundamental rocks and the conditions affecting them was very marked. One of the most striking examples was to be seen along the great fault which had been described. The Huronian country on the north-west was elevated and mountainous up to the very contact, and it overlooked the Laurentian area, which stretched far off to the eastward as a comparatively level plain.

On Thursday evening the visiting members of the Geological Society were entertained to a banquet by the Logan club, which consists of the scientific staff of the Canadian Geological Survey. Among those present were lord Stanley, governor-general of Canada, Sir John Thompson, premier of the dominion, T. M.

Daly, minister of the interior, and many other distinguished Canadians.

After the viands had been disposed of the toasts of *the queen, the president of the United States*, and *the governor-general* were enthusiastically drunk. In responding to the latter, lord Stanley made a very felicitous speech, in which he expressed the great pleasure that it gave him to extend Canada's welcome to the scientific men from the adjoining republic, assuring them that the oftener they came, the more they would be appreciated, and the better it would be for both countries. He humorously referred to his abundant opportunities for the study of geology and palæontology on the road from the Government house to the Parliament buildings.

In answer to the toast of *our guests*, professor Emerson of Amhurst college, made an admirably witty speech. He was followed by professor G. F. Wright and Mr. W. J. McGee, the latter of whom proposed the toast of the *Parliament of Canada*. This was responded to by Sir John Thompson who said that on this, his first opportunity since becoming premier, of giving an outline of the policy of the government he could assure them that, on one point, at least, the parliament would be unanimous, and that was in offering a most cordial welcome to the scientists of America. The differences of opinion in commercial and political matters had no counterpart in science.

The Geological Society of America was proposed by Sir James Grant, and answered by president Gilbert; the *Geological Survey of Canada* was proposed by professor Fairchild and answered by Mr. Daly, minister of the interior, and the *Press* was answered by Mr. Shannon, editor of the *Ottawa Citizen*. The company then sang the British national anthem, and a very pleasant and profitable evening was brought to a close.

On Friday morning Mr. G. K. Gilbert gave the annual presidential address on the subject "Problems of the Continents."

After alluding to the interest manifested at the present time in continental and inter-continental subjects, and to the geological work of the coming Congress of Geologists on the occasion of the World's Fair at Chicago, Mr. Gilbert reviewed the broader of the problems in geophysics and geological history as they affect the continents. Recognizing the continental plateau, as distinct from the dry land continents, it is a question how it is sustained, the rival theories being those of terrestrial rigidity and isostasy. The doctrine of isostasy is gaining adherents, but is not universally accepted. If accepted, it leaves the question whether the lightness of continental rock material is due to relatively high temperature or to composition. For the origin of the continents the only well-digested theory in the field is that of Dana, and that has not yet been fully compared with the body of new facts contributed by the last decade. The permanence of continents, though widely accepted, is not yet fully established; and the doctrine that continents have steadily grown from Archean to Pleistocene, though universally taught, is not yet placed beyond question. Thus the continents offer to the congress of next summer a number of fundamental problems worthy of the most careful consideration.

After the presidential address the reading of papers was resumed:

W. H. C. SMITH – The Archæan rocks west of lake Superior.

This paper gave a brief description of the rocks and their distribution between the lake of the Woods and lake Superior north of the international boundary and referred to some of the theories of origin and structure of the various members of the Archæan system and to the iron ores and gold-bearing rocks of the region.

ALFRED E. BARLOW—The relations of the Laurentian and Huronian rocks north of lake Huron.

In this paper, which is a revision and extension of one published in the AMERICAN GEOLOGIST of July, 1890, the writer traced the line of junction between the Laurentian and Huronian from Killarney (Shibaananing) on lake Huron, to Wahnapitæ station on the Canadian Pacific railway (12 miles east of Sudbury). Brief descriptions were also given of the contacts exposed near Straight Lake station, and in the vicinity of Thessalon, Ont. The various phenomena were described in detail, and the general conclusion arrived at that the Laurentian gneiss is of irruptive origin and was in a magmatic condition at a time subsequent to the hardening of the Huronian sediments. There is thus no question as to conformity or unconformity between these two great divisions, as the contact, wherever exposed shows abundant evidence of the intrusive nature of the gneiss, breaking through and altering the Huronian quartzites.

C. R. VAN HISE—The volcanics of the Huronian south of lake Superior.

On Friday afternoon Mr. W. J. McGee gave an interesting account of the work of the U.S. Geological Survey, both inregard to the general plan of its execution, and the scientific results aimed at or already attained. The beautiful new atlas of portions of Tennessee was shown to give a clear idea of what was being accomplished with the combined efforts of the topographical and the geological staffs.

The next paper was:

C. WILLARD HAYES and M. R. CAMPBELL—Geomorphology of the southern Appalachians.

This was presented by Mr. Hayes, who gave a clear and instructive account of the changes of level and configuration that the southern Appalachian country has undergone in post-Mesozoic times.

At half past three the society adjourned and the members went to the Government house where lady Stanley was giving an *at home*, "to meet the members of the Geological Society of America." The toboggan slides and skating and curling rinks were open, while the drawing rooms were bright with the beauty of the Canadian capital. Here two exceedingly pleasant hours were spent, enjoying the hospitality of the very charming English lady who is at present the leader of Canadian society.

On Friday evening, December 30, the final meeting of the society was held, when the following papers were read:

JAMES MCEVOY—Notes on the Gold range in British Columbia.

A short description of the topography of the gold range and part of the adjoining interior plateau country, with notes on the glacial geology of the same.

ISRAEL C. RUSSELL—A geological reconnoissance in the central part of the state of Washington. (Read by title.)

R. W. ELLS—The importance of photography in illustrating geological structure.

The latter was a verbal description of a series of large colored photographs showing the mode of occurrence of apatite in the deposit of the Buckingham and Lievre district, as well as the relations of the intrusive apatite-bearing rocks to the surrounding gneiss. The apatite was stated to occur in intrusive dykes of pyroxenite diorite, which in some places ran with the foliation of the gneiss, and in other places across it.

CHARLES ROLLIN KEYES—Some Maryland granites and their origin.

A brief sketch of the granitic rocks of Maryland with a summary of the reasons for regarding them as eruptive in origin.

CHARLES ROLLIN KEYES—Epidote as a primary component in granites.

Occurrences of the mineral in certain granites regarded as eruptive described, the evidences of its original nature explained and its associations with the closely related allanite considered.

J. S. DILLER—On the Cretaceous and Tertiary of the Pacific states.

The Cretaceous of California, composed of the Knoxville, Horsetown, Wallala and Chico beds, has hitherto been regarded as an interrupted series. The Shasta (Lower Cretaceous) comprising the Knoxville and Horsetown beds, has been supposed to have been separated from the Chico (Upper Cretaceous) by a long time interval, the latter part of which was believed to be represented by the Wallala beds.

Extensive field studies of the stratigraphy and collections of fossils from over eighty different localities in the Cretaceous show that the Wallala is a part of the Chico and that the Shasta and Chico are not only conformable, but that over one-fourth and nearly one-half of the Shasta fossils continue up into the Chico. It is evident that there is faunal as well as stratigraphic continuity and that the sedimentation was uninterrupted throughout the Shasta-Chico series

This series is unconformable on the Jura-Trias and Paleozoic rocks. About the close of the Jurassic in the northern Sierras and Klamath mountains of California, the older strata were raised above the sea and exposed to subaerial degradation. During the Cretaceous the land subsided and the sea transgressed upon the western base of the Sierra Nevada and almost the whole of northern California and Oregon, forming deposits of the older residuary material but little removed from its source.

In Oregon the Eocene is unconformable on the Shasta-Chico series in such a way as to show the upturning and erosion of that series at the close of the Cretaceous. Of the mountain forming epochs on the Pacific coast, the one about the close of the Jurassic and the next at the close of the Cretaceous are considered to be among the greatest.

T. W. STANTON.—On the Faunas of the Shasta and Chico Formations.

The Cretaceous deposits of the Pacific coast of the United States have hitherto been supposed to contain at least two distinct faunas, the older of which characterizes the Shasta formation while the later occurs in the Chico and has been supposed to be intimately connected

with the Tejon, passing up without any break into a characteristic Eocene fauna. The Shasta fauna and the Chico fauna were believed to have so little in common that a time-hiatus was inferred to exist between them.

The present paper, based principally on the study of Mr. J. S. Diller's collections from northern California, Oregon and Washington, shows that there is an intimate commingling of Shasta and Chico species and that all the fossils from both formations seem to belong to a single fauna. This is especially well shown in the collections from Horsetown and various localities on Cottonwood creek, Shasta county, California.

The Shasta-Chico fauna contains many species that are closely related to forms described from the English Blackdown beds (Gault or Cenomanian), while very few, if any, of its species are identical with those found in the Upper Cretaceous beds in the interior of the United States east of the Rocky mountains. It is therefore suggested that a considerable part of the Upper Cretaceous series may be lacking in the Pacific states. The conclusions reached concerning the relationship of the faunas of the Shasta and Chico formations are probably also true of the Queen Charlotte and Vancouver faunas of British Columbia.

N. H. DARTON—Overthrust faults in eastern New York.

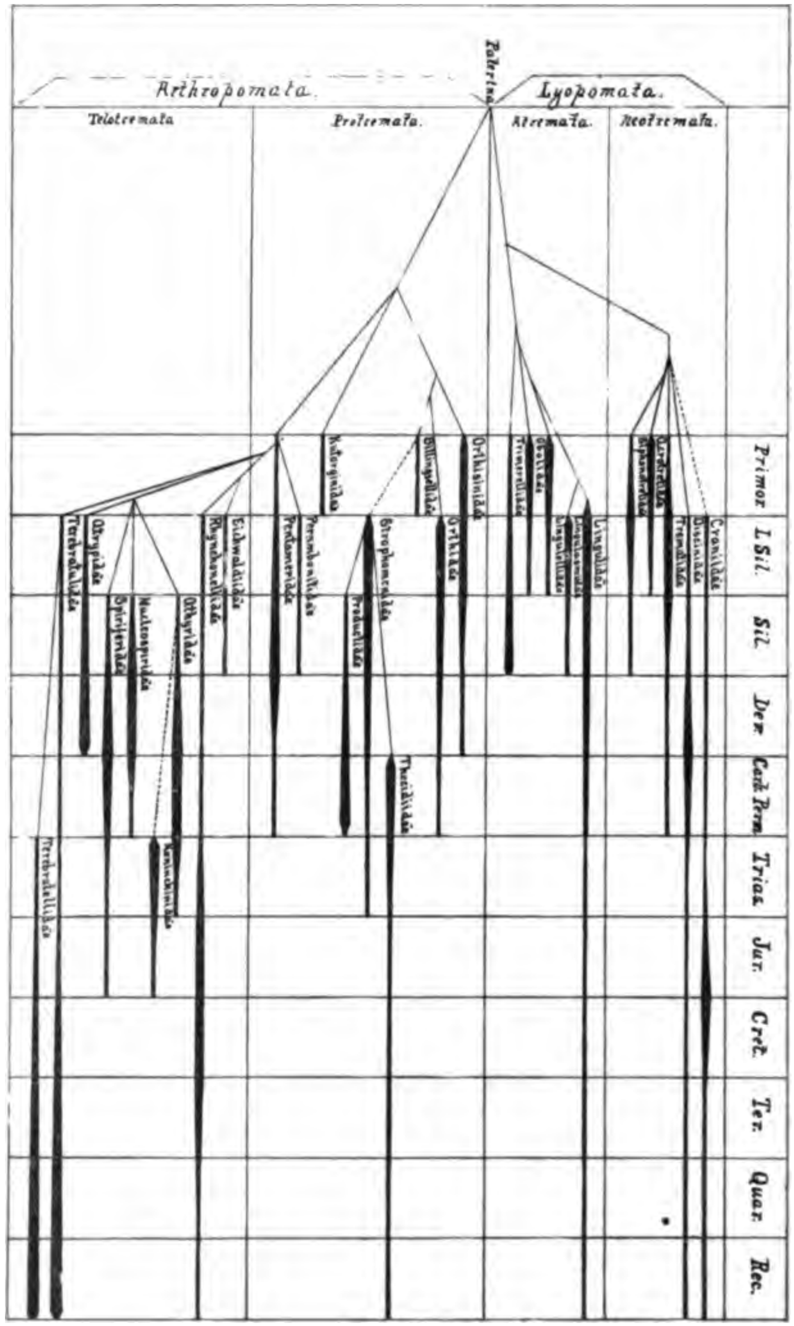
Gave an account, with illustrations, of some small but typical overthrust faults in the rocks of eastern New York.

It was then moved by Mr. F. D. Adams, seconded by Mr. C. R. Van Hise, and unanimously carried, "that the thanks of the Society be tendered to his excellency, the governor-general of the dominion of Canada, for the cordial welcome which he extended to the Society, and to her excellency, lady Stanley, for her very kind hospitality. To the Logan Club for its invitation to the Society to meet in Ottawa and for its generous hospitality, and especially to its committee, consisting of Messrs. Selwyn, Ells, Tyrrell and W. H. Smith, whose untiring efforts have so largely contributed to the success of the meeting. To the Royal Society of Canada, for its invitation to meet in Ottawa, and its kind attentions during the Society's visit. And to the clerk of the House of Commons for the ample suite of rooms which he placed at the disposal of the Society during this, its fifth annual meeting."

Before dispersing Messrs. Fairchild, McGee and Emerson all gave voice to the general sentiment that the meeting was one of the most successful in the history of the society.

To all the members present, and more especially to those from Ottawa itself, the meeting has a mournful interest, as it completed the life work of Mr. W. H. Smith, the secretary of the local committee and a member of the staff of the Canadian Geological Survey, whose constant attention did so much to make the meeting a success.

After the reading of his paper, on Friday, he was obliged to keep to his home by an attack of acute catarrh. This developed into pleurisy, and to it he succumbed on the evening of January 19th.


Arthropomata.
Paterina.
Lyopomata.
Telotremata.
Protremata.
Atremata.
Neotremata.
Kutorgiidae
Billingsellidae
Orthisinidae
Strophomenidae
Orthidae
Lingulidae
Craniidae
Discinidae
Terebratulidae
Atrypidae
Spiriferidae
Nucleospiridae
Athyridae
Rhynchonellidae
Eichwaldiidae
Pentameridae
Productidae
Thecidiidae
Terebratellidae
Primor
L.Sil.
Sil.
Dev.
Carb. Perm.
Trias.
Jur.
Cret.
Ter.
Quar.
Rec.

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A CLASSIFICATION OF THE BRACHIOPODA.

BY CHARLES SCHUCHERT, New Haven, Conn.

PLATE V.

The class Brachiopoda, since 1858, has been divided by nearly all systematists into two orders, based on the absence or presence of articulating processes. These divisions were recognized by Deshayes as early as 1835, but not until twenty-three years later were the names *Lyopomata* and *Arthropomata* given them by Owen. These terms have been generally adopted by writers, though some prefer *Inarticulata* and *Articulata* of Huxley, or Bronn's *Ecardines* and *Testicardines*. Bronn,[5] in 1862, and King,[3] in 1873, while retaining these divisions, considered the presence or absence of an anal opening more important than articulating processes, and accordingly proposed the terms *Pleuropygia* and *Apygia*, and *Tretenterata* and *Clistenterata*, respectively. Many paleozoic rostrate species of *Clistenterata*, however, give evidence that an anal opening was also present, and, therefore, the absence or presence of this organ is not so persistent a character as that of a hinge.

Von Buch,[1] in 1834, also divided the class into two sections, founded on the mode of attachment. The first section contained all brachiopods fixed by a pedicle to foreign bodies, while the second is restricted to those forms in which there is no pedicle at maturity, the entire lower or ventral valve being cemented to other

objects, as in *Crania*. The first section is again divided into three groups, on the basis of the position of the pedicle, (*a*) pedicle emerging from between the valves, as in *Lingula*, (*b*) ventral valve perforated for the protrusion of the pedicle, and (*c*) uncemented shells without a pedicle opening. The third group, however, is identical with *b*, since *Leptæna*, *Productus* and *Strophomena*, genera referred to section *c*, do possess a pedicle opening. While this classification lacks a complete understanding of the features in question, it is remarkable that Von Buch, nearly sixty years ago, and Deslongchamps,[6] twenty-eight years later, recognized some of the principles upon which the classification of the Brachiopoda is now being established, viz.: the nature of the pedicle opening.

Up to 1846 the general external features of brachiopods served the majority of authors as the essential basis for generic differentiation. In that year, however, King[2] pointed out that more fundamental and constant characters exist in the interior of the shell, a fact which soon came to be generally recognized, mainly through the voluminous writings of Thomas Davidson.

In 1848, Gray,[4] probably stimulated by King's[2] paper, divided the Brachiopoda into two sub-classes, *Ancylopoda* and *Helictopoda*. These divisions rest entirely on the basis of the arm structure and the presence or absence of a calcareous support. The *Ancylopoda* are distinguished in having the "oral arms recurved and affixed to fixed appendages on the disk of the ventral [dorsal] valve," while in *Helictopoda* "they are regularly spirally twisted when at rest." The brachia, however, in all recent species, are recurved and more or less spirally enrolled, except in some geratologous forms of loop-bearing genera, as *Cistella* and *Gwynia*. Therefore *Helictopoda*, as far as the arm structure is concerned, will also include the *Ancylopoda*. In fact, to the former he referred only the terebratuloids, if *Thecidium* is excluded, while *Ancylopoda* contained all other brachiopods whether articulate or inarticulate forms. These sub-classes are further divided, on the basis of the brachia, into four orders, *Ancylobrachia*, *Cryptobrachia*, *Sclerobrachia*, and *Sarcicobrachia*. Of these the first only can be retained as a sub-order, since it includes the loop-bearing genera. The other orders have so heterogeneous an assemblage of forms as to be of no permanent value.

Beyond the introduction of new families, no further attempt

was made by writers to divide the Brachiopoda into other orders than *Lyopomata* and *Arthropomata* until 1883, when Waagen[8] published his great work on the fossils of this class from the Salt Range group of India. He found it "absolutely necessary" to further divide the *Lyopomata* and *Arthropomata* each into three suborders. The basis for these suborders has no underlying principle of general application, yet the divisions are of permanent value, for each contains an assemblage of characters not to be found in any of the others. Waagen's genealogy of the *Arthropomata*, with *Orthis* as the prototype, falls at once to the ground, since Hall[14] has recently shown that probably no true *Orthis* exists in the primordial. The orthis-like shells of the primordial are forms either with a deltidium or a spondylium (the interior spoon-shaped plate of pentameroids) or both plates present in the same individual. Ephebolic *Orthis* do not possess either structure, but during nepionic and early nealogic growth may develop a deltidium, which, before maturity is attained, is lost by abrasion or concealed by the incurvature of the ventral beak. *Lingula*, on the other hand, is usually regarded as the prototype for all brachiopods, but this is impossible, since a number of inarticulate genera flourished for ages before *Lingula* was developed.

No classification can be natural and permanent unless based on the history of the class (chronogenesis) and the ontogeny of the individual. However, as long as the structure of the early paleozoic genera remained practically unknown and the ontogeny untouched, nothing could be attempted of a permanent nature. Recently a work[14] upon paleozoic brachiopods has been published, in which many of the early genera are clearly defined, so that their structures and geologic sequence are now more accurately known. The ontogenetic study of paleozoic species was initiated two years ago by Beecher and Clarke,[11] and the results combined with those derived from the development of some recent species, and published by Kovalewsky, Morse, Shipley, Brooks and others, confirm the conclusions reached through chronogenesis. Moreover, the application by Dr. Beecher,[12, 13] of the law of morphogenesis as defined by Hyatt,[9, 10] and the recognition and establishment of certain primary characters, have resulted in the discovery of a fundamental structure of general application to the classification of these organisms. It has for its basis the nature of the pedicle opening and the stages of shell growth. On this the author has

divided the class into four orders, the *Atremata*, *Neotremata*, *Protremata* and *Telotremata*. In the *Atremata*, the pedicle passes "freely from between the two valves, the opening being more or less shared by both," while in the *Neotremata*, the pedicle opening is restricted to one valve, the ventral, "remaining open in primitive mature forms [*Trematidæ*], becoming enclosed in secondary forms during nealogic stages [*Discinidæ*], and in derived types enclosed in early nealogic or nepionic stages [*Acrotretidæ*]." In the *Protremata*, there is a deltidium (the pseudo-deltidium of authors), which, in the earliest primordial, appears to begin as a short plate covering but a small portion of the delthyrium (*Kutorgina cingulata* after Walcott, according to Beecher). This plate rapidly attains its full growth, closing the entire delthyrium of the ventral valve, as in *Clitambonites* and *Billingsella*, while in the *Orthidæ* it is developed only during nepionic or nealogic growth. The delthyrium in the *Telotremata* is without any trace of covering during nepionic growth, but during the succeeding stages there grow out from the walls of the former two plates (the deltidial plates) which usually meet medially, and may become anchylosed.

It is remarkable that three of the four types of pedicle openings should appear in the earliest known horizon of the primordial, yet fundamental structures in other classes of organisms have developed with equal rapidity. Prof. Hyatt[9] says "the acknowledged sudden appearance of the larger number of all the distinct types of invertebrata in the paleozoic, and of the greater number of all existing and fossil types before the expiration of the paleozoic time, speak strongly for the quicker evolution of forms in the paleozoic and indicate a general law of evolution. This, we think, can be formulated as follows: Types are evolved more quickly and exhibit greater structural differences between genetic groups of the same stock while still near the point of origin, than they do subsequently. The variations or differences may take place quickly in the fundamental structural characteristics, and even the embryos may become different when in the earliest period, but subsequently only more superficial structures become subject to great variations." All the fundamental structures, as the four types of pedicle openings and the various calcareous supports of the brachia, were in existence during the Trenton period of the Lower Silurian.

In tracing the four types of pedicle openings to their origin, it is found that the *Telotremata* were the last to appear, having been developed in the *Pentameridæ* of the *Protremata*. The *Atremata* gave rise to the *Neotremata* and *Protremata*. Since *Lingula* of the *Atremata* is not the prototype for the class as it passes through a paterina and obolella stage, this must be looked for in a shell not passing through more than one stage. *Paterina* is this type, being the most primitive genus known, as well as the adult form representing the embryonic shell or protegulum of other brachiopods. The *Atremata* through the *Trematidæ* gave origin to the *Neotremata*, while the *Protremata* originated in *Kutorginidæ*, which is one of the first steps from the inarticulate towards the articulate forms.

Of secondary value for classification the writer has relied on the presence or absence of a straight hinge line, internal plates, calcareous brachial supports, and reversional or geratologous development. In some families, containing chiefly rostrate forms, as in the *Pentameridæ* and *Nucleospiridæ*, there are genera with short straight hinge lines. In other families where long hinges are prevalent, rostrate examples, as in the *Orthidæ* and *Spiriferidæ*, are found. The exceptions are either specializations or reversional tendencies, and when sufficiently pronounced are regarded as of subfamily importance. Examples of geratology are present in most of the four orders, but particularly in the *Terebratellidæ*, where the *Megathyrinæ* and *Kraussininæ* have partially or entirely lost their calcareous brachial appendages.

The accompanying plate, (pl. v.) giving the apparent genesis of the families and their geological distribution, is added so that students can have before them on a single page a summary of the classification here proposed. It should be borne in mind, however, that the lines are but a graphic expression of our present information of the class, and that future study may change their arrangement.*

Dall[5] in his Index says "from the preceding list it appears that about four hundred and sixty-three generic and subgeneric names have been rightly or wrongly associated with the group of

*The names *Lingulasmiidæ* and *Orthisinidæ* should be changed to *Lingulasmatidæ* and *Clitambonitidæ*.

Brachiopoda. * * * Of all these only about one hundred and thirty have been at all generally accepted." It should be stated that many of the synonyms are errors in composition and corrections in orthography.

In the following list there are two hundred and seventy-seven valid genera or subgenera, a growth of more than twofold since the date (1877) of Dall's Index. Forty-seven families or subfamilies are here recognized, while in that list there are but eighteen.

An analysis of the table of geological distribution shows conclusively that the class attained its climax of diversity during paleozoic time. In the lower third of the primordial, the Olenellus horizon, three of the four orders are already present, while the fourth originates in the lower portion of the Lower Silurian. Not even a single suborder was introduced subsequent to the Lower Silurian. Of the forty-seven families and subfamilies constituting the class, thirty-six became differentiated in the paleozoic, and of these, twenty-seven disappeared with it, while but nine continued into the mesozoic. Of paleozoic families, six are represented by living species, viz.: *Lingulidæ*, *Discinidæ*, *Craniidæ*, *Thecidiidæ*, *Rhynchonellidæ*, and *Terebratulidæ*.

Of the two hundred and seventy-eight genera now in use, one hundred and eighty-six had their origin in paleozoic seas, or two-thirds of the entire class, and of this great number but seven are known to pass into the mesozoic, viz.: *Lingula*, *Orbiculoidea*, *Crania*, *Spiriferina*, *Athyris*, *Terebratula*, and *Hemiptychina*. Besides these, *Cyrtina* and *Retzia* are often mentioned as occurring in the Triassic, but the species probably belong to other genera.

In the primordial, brachiopods are not numerous. They usually differ fundamentally from each other, and do not appear to have been persistent, as but four of the twenty-two genera pass into the Lower Silurian. In the Silurian and Devonian, the class is very prolific in species and genera. Of the fifty-one genera occurring in the Carboniferous but seven are known to have survived the break between the paleozoic and mesozoic. During the latter period, the spire-bearing brachiopods pass out of existence, while the great paleozoic suborder *Thecacea* is represented by a few small species of the *Thecidiida* which continued to be represented up to the present time. The *Terebratulidæ* had their in-

ception in the Lower Silurian, but are not a pronounced paleozoic group. However, on reaching the Jurassic and Cretaceous, the rocks fairly abound with their shells, and from that time on they are the chief representatives of the class. *Lingula* and *Crania* are present in the Lower Silurian, and as far as can be determined have persisted to the present time.

The *Atremata*, which contains the oldest and the simplest forms structurally, is represented by twenty-four genera, while the *Neotremata* and *Protremata* originating almost simultaneously from the former have thirty-one and eighty-two, respectively. The *Telotremata* had its origin in the *Neotremata*. It is the last order to appear, and has by far the greatest number of genera, one hundred and thirty-eight.

To Dr. C. E. Beecher the writer is indebted for many valuable suggestions, as well as for the careful reading of the manuscript of this paper.

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Synonyms are in brevier under the name to which they are referred.

An interrogation mark before a name indicates that the family or subordinal relation is in doubt.

BRACHIOPODA.

(Cuvier 1802), Dumeril 1806.

Spirobranchiophora, Gray 1821; Palliobranchiata, Blainville 1824; Branchiopoda, Risso 1826 (not Latreille); Brachiopodidæ, Broderip 1839; Branchionopoda, Agassiz 1847; Brachionacephala, Bronn 1862; Spirobranchia, Haeckel; Branchionobranchia, Pætel 1875.

Subclass **LYOPOMATA,** Owen 1858.

Helictopoda (part), and Sarcicobrachia (part), Gray 1848, King 1850; Pleuropygia, and Ecardines, Bronn 1862; Inarticulata, Huxley 1864; Tretenterata, King 1873.

Order **Atremata,*** Beecher 1891.

Mesokaulia, Waagen 1885.

1. Family PATERINIDÆ,† n. fam.

Paterina, Beecher 1891.

2. Family OBOLIDÆ,‡ King 1846.

Obolella, Billings 1861.
Dicellomus, Hall 1871.
Elkania, Ford 1886.
Neobolus, Waagen 1885.
? Spondylobolus, McCoy 1852.

Obolus, Eichwald 1829.
Ungula, Pander 1830.
Ungulites, Bronn 1848.
Aulonotreta, Kutorga 1848.
Acritis, Volborth 1868.
Schmidtia, Volborth 1869 (not Bals-Criv. 1863).

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*This order is characterized by the pedicle passing out freely between the valves, while in the NEOTREMATA it is restricted to one valve emerging through a variously modified opening.

†*Paterina*, of the lowest primordial, is the simplest shelled condition of brachiopods known. Its growth lines show that it does not pass through distinct stages of growth in the shell as do all other families of this class. Nearly all brachiopods begin their shelled existence with a paterina-like stage. The protegulum or embryonic shell, of the Brachiopoda is minute, and therefore usually not observable on mature specimens, but where well-preserved young, either fossil or recent, have been accessible it is always seen to be present. Inarticulate species or the dorsal valve of articulate forms often retain it in the mature condition. The protegulum is homologous with the protoconch of cephalopods and gastropods and the prodissoconch of pelecypods. *Paterina*, therefore, represents a form of growth common to the protegulum and nepionic stages of the majority of brachiopods.

‡The lingula-shaped shells with obolelloid interiors, the LINGULELLIDÆ, are removed from this family since it is very probable that from them developed the LINGULIDÆ. In this connection, the writer wishes to state that *Lingulella*, as here understood, is based on *L. cœlata* Hall, sp., and *L. ella* Hall and Whitfield.

The obolelloids are thicker, more calcareous, and rounder shells than the LINGULELLIDÆ, and in all probability gave origin to the TRIMERELLIDÆ.

3. Family TRIMERELLIDÆ, Davidson and King 1874.

? Lakmina, Œhlert 1887.	Monomorella, Billings 1871.
Davidsonella, Waagen 1885 (not Munier-Chalmas 1880).	Trimerella, Billings 1862.
Dinobolus, Hall 1871.	Gotlandia, Dall 1870.
Conradia, Hall MS. 1862.	Rhynobolus, Hall 1874.
Obolellina, Billings 1871.	
Ungulites, Quenstedt 1871 (not Bronn 1848).	

2′. Family LINGULELLIDÆ,* n. fam.

Lingulella, Salter 1866.	Paterula, Barrande 1879.
Lingulepis, Hall 1863.	Cyclus, Barrande 1879.
Leptobolus, Hall 1871.	?Mickwitzia, Schmidt 1888.

2″. Family LINGULIDÆ, Gray 1840.

Lingula, Bruguière 1792.	Dignomia, Hall 1871.
Pharetra, Bolton 1798.	Glottidia, Dall 1870.
Lingularius, Dumeril 1806.	Barroisella, Hall 1892.
Glossina, Phillips 1848.	Thomasina, Hall 1892.

3′. Family LINGULASMATIDÆ,† n. fam., Winchell and Schuchert.

Lingulops, Hall 1871.	Lingulasma, Ulrich 1889.
	Lingulelasma, Miller 1889.

Order **Neotremata**,‡ Beecher 1891.

Suborder **Daikaulia**,§ Waagen 1885.

1. Family TREMATIDÆ, n. fam.

Discinolepis, Waagen 1885.	Schizobolus, Ulrich 1886.

*See foot-note to the OBOLIDÆ.

†The species of this family are platform-bearing linguloe. Internally their relations are with the TRIMERELLIDÆ, but the elongate shape and strongly phosphatic nature of their shells combined with their later appearance in geologic time give strong support to the view that they have originated from another phylum, the LINGULIDÆ, rather than that which gave rise to the TRIMERELLIDÆ, the OBOLIDÆ.

‡"Pedicle fissure remaining open in primitive mature forms, becoming enclosed in secondary forms during nealogic stages, and in derived types enclosed in early nealogic or nepionic stages."

§The suborder DAIKAULIA contains the inarticulate uncemented species in which the passage for the pedicle is through one valve during all nealogic and ephebolic stages of growth. In the TREMATIDÆ is probably indicated one of the first steps from the OBOLIDÆ towards the ACROTRETIDÆ. Succeeding growth to the protegulum, in the former family, is not holoperipheral, but ceases at its straight cardinal line, leaving, posterior to the protegulum, a more or less wide triangular notch in the ventral valve. In the DISCINIDÆ, early growth is as in the TREMATIDÆ, but before maturity is attained the two sides of the pedicle passage are gradually brought together, forming a long narrow depression in the shell, at the anterior end of which the pedicle emerges. The reduction in size of the pedicle notch progressed rapidly in the ACROTRETIDÆ towards a small circular perforation. In these families, the protegulum is invariably situated at the anterior end of the pedicle passage, while in the dorsal valve it is marginal. In the SIPHONOTRETIDÆ, during younger stages of growth, the pedicle opening was probably marginal, but long before maturity is attained the opening is carried anteriorly through the protegulum and nepionic growth by resorption of the shell, while a deposition takes place posteriorly underneath the pedicle.

Trematis, Sharpe 1847.
Orbicella, d'Orbigny 1847.
Schizocrania, Hall and Whitfield 1875.

Œhlertella, Hall 1890.
Lingulodiscina, Whitfield '90.
? Monobolina, Salter 1865.

2. Family DISCINIDÆ, Gray 1840.

Orbiculidæ, McCoy 1844.

Orbiculoidea, d'Orbigny 1847.
Schizotreta, Kutorga 1848.
Lindstrœmella, Hall 1890.
Rœmerella, Hall 1890.

Discina, Lamarck 1819.
Orbicula, Sowerby 1830 (not Cuvier 1798).
Disciniscа, Dall 1871.

2'. Family ACROTRETIDÆ, n. fam.

Iphidea, Billings 1872.
Acrothele, Linnarsson 1876.
Linnarssonia, Walcott 1885.
Discinopsis (Matthew), Hall 1892.

Acrotreta, Kutorga 1848.
Conotreta, Walcott 1889.
? Mesotreta, Kutorga 1848.
? Volborthia, von Möller 1873.

3. Family SIPHONOTRETIDÆ, Kutorga 1848.

Siphonotreta, de Verneuil 1845.
Schizambon, Walcott 1884.
Schizambonia, Œhlert 1887.

? Keyserlingia, Pander 1861.
? Helmersenia, Pander 1861.

Suborder **Gasteropegmata**, Waagen 1885.

Family CRANIIDÆ, King 1846.

Orbiculæ, Deshayes 1830; Craniadæ, Gray 1840.

Crania, Retzius 1781.
Nummulus, Stobæus 1732.
Criopus, Poli 1791.
Criopoderma, Poli 1795.
Orbicula, Cuvier 1798 (not Sowerby 1830).
Orbicularius, Dumeril 1806.
Craniolites, Schlotheim 1820.
Discina, Turton 1832 (not Lamarck 1819).
Criopododerma, Agassiz 1846.
Choniopora, Schauroth 1854.

Craniella, Œhlert 1888.
Cardinocrania, Waagen 1885.
Ancistrocrania, Dall 1877.
Cranopsis, Dall 1871 (not A. Adams).
Craniscus, Dall 1871.
Siphonaria, Quenstedt 1851 (not Sowerby).
Pholidops, Hall 1860.
Craniops, Hall 1859.
Pseudocrania, McCoy 1851.
Palæocrania, Quenstedt 1871.

Subclass **ARTHROPOMATA**, Owen 1858.

Helictopoda (part), Sarcicobrachia (part), Ancylopoda and Acylobrachia, Gray 1848; Apygia, Testicardines, Lineicardines and Denticardines, Bronn 1862; Articulata, Huxley 1864; Clistenterata, King 1873.

Order **Protremata,*** Beecher 1891.

Suborder **Trullacea,†** n. suborder.

Aphaneropegmata (part), and Productacea (part), Waagen 1883; Eleutherobranchiata (part), Neumayr 1883.

1. Family KUTORGINIDÆ,‡ n. fam.

Kutorgina, Billings 1861.	Schizopholis, Waagen 1885.

2. Family CLITAMBONITIDÆ,§ n. fam., Winchell and Schuchert.

Orthisidæ (part), d'Orbigny 1849; Orthisinæ, Waagen 1884.

Clitambonites, Pander 1830.	Protorthis, Hall 1892.
Pronites, Pander 1830.	Hemipronites, Pander 1830.
Gonambonites, Pander 1830.	Scenidium, Hall 1860.
Orthisina, d'Orbigny, 1847.	Mystrophora, Kayser 1871.
Polytœchia, Hall 1892.	

2′. Family PENTAMERIDÆ, McCoy 1844.

Hypothyridæ (part), King 1850; Pentameridæ, Hall 1867; Camerophoriinæ and Pentamerinæ, Waagen 1883; Stenochismatinæ and Conchidiinæ, Œhlert 1887.

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*Some of the oldest forms of this order have at maturity an incomplete deltidium, which rapidly attained its full development, so that in other species it covers the entire delthyrium of the ventral valve. In the ORTHIDÆ, the deltidium is usually absent or rudimentary at maturity, but may be present in the nepionic and sometimes in early nealogic stages.

†*Trulla*, a scoop. Having reference to the spoon-shaped plate in the ventral valve ("spondylium" of Hall), to the upper surface of which were attached the adductor, ventral pedicle and divaricator muscles.

The species of this suborder are the earliest articulate forms known. In the lowest primordial, there are long-hinged and rostrate forms, having usually a spondylium and deltidium. These structures are regarded as of prime importance in classification, and species possessing them are therefore placed at the base of the ARTHROPOMATA, and are considered as ancestral forms for all articulate genera. After these parts are fully developed, the tendency, in geologic sequence, is to eliminate the spondylium, retaining the deltidium in the THECACEA, while in the PENTAMERIDÆ the reverse has usually taken place. Forms wider than long, having a spondylium and usually a deltidium, the CLITAMBONITIDÆ, became extinct with the Devonian, while the rostrate genera, in which the deltidium is commonly rudimentary or absent, persist to the close of the paleozoic age. Those forms with a deltidium and no spondylium, the THECACEA, appear to be present in the lowest primordial, but are not characteristic until the upper third is attained, and are still living in *Thecidium*. At the base of the Lower Silurian, species are developed without either of these structures, the ORTHIDÆ, passing out of existence with the paleozoic. The RHYNCHONELLIDÆ were in all probability derived from the PENTAMERIDÆ, and from them developed almost simultaneously the HELICOPEGMATA and ANCYLOBRACHIA.

‡The genera referred to this family have usually been placed among the LYOPOMATA. *Kutorgina cingulata*, Billings, the type of *Kutorgina*, as described and illustrated by Walcott (Bull. no. 30, U. S. Geol. Surv.), has more the characters of an articulate than an inarticulate brachiopod. This species has rudimentary articulating processes. Good examples of it show that the lateral walls of the ventral cardinal area are linear, increasing in width towards the line of junction of this valve with the dorsal, and it is here that the rudimentary teeth are situated. In *Schizopholis*, the rudimentary cardinal walls of *Kutorgina* are fully developed, the delthyrium is reduced to a narrow triangular fissure, which in the latter nearly occupies the entire posterior area. Beecher has also observed that *K. cingulata* has a short, perforated, deltidium in the apical portion of the ventral valve.

§This family is proposed for the long-hinged forms with spondylia, the majority of which also have a well-developed deltidium perforated for the passage of the pedicle. The PENTAMERIDÆ is restricted to the rostrate forms of essentially the same internal structure, with the deltidium usually entirely or partially obsolete in adult specimens.

Camarella (part), Billings 1859.
Anastrophia, Hall 1867.
  Brachymerus, Shaler 1865 (not Dej. 1834).
Conchidium, Linné 1760.
Pentamerus, Sowerby 1813.
  Pentastère, Blainville 1824.
  Gypidia, Dalman 1828.
Pentamerella, Hall 1867.
Gypidula, Hall 1867.
Amphigenia, Hall 1867.
Camarophoria, King 1850.
  Stenochisma, Dall 1877; Œhlert 1887 (not Conrad 1839).
Stricklandinia, Billings 1863.
  Stricklandia, Billings 1859.
Sieberella, Œhlert 1887.
Antirhynchonella, Quenstedt 1871.
Lycophoria, Lahusen 1885.

3. Family PORAMBONITIDÆ, Davidson 1853.

Porambonites, Pander 1830.
  Priambonites, Agassiz 1847.
  Isorhynchus, King 1850.

Suborder **Thecacea**,* n. suborder.

Aphaneropegmata (part), Productacea, Coralliopsida, and Kampylopegmata (part), Waagen 1883; Eleutherobranchiata (part), Neumayr 1883; Cryptobrachia (part), Gray 1848.

Family BILLINGSELLIDÆ,† n. fam.

Billingsella, Hall 1892.

Family STROPHOMENIDÆ, King 1846.

Subfamily ORTHOTHETINÆ, Waagen 1884.

Strophomeninæ (part), Waagen 1884.

? Orthidium, Hall 1892.
Strophomena, Blainville 1825.
  Hemipronites, Meek 1872 (not Pander 1830).
Kayserella, Hall 1892.
Derbya, Waagen 1884.
Meekella, White and St. John 1870.

**Theca*, a cover. Having reference to the deltidium of one piece covering the delthyrium or triangular fissure in the apical portion of the ventral valve. The THECACEA differ chiefly from the TRULLACEA, from which they were derived, in being without the complete internal spoon or spondylium. See note to TRULLACEA.

†Those primordial species essentially orthoid in structure, but with a large deltidium and a more or less complete chilidium, have been referred to *Billingsella* by Hall. The writer is of the impression that *Billingsella* or some closely allied genus gave origin to the ORTHIDÆ, and that the former were derived from some species also having, in addition to the above mentioned characters, a spondylium, or essentially a *Clitambonites*. The progression towards *Orthis* from *Clitambonites* appears to have been in first eliminating the spondylium by attaching it to the bottom of the ventral valve, thus forming the dental plates and the somewhat elevated muscular area of *Billingsella*. The next step is to remove the deltidium and chilidium and to develop a more pronounced cardinal process to produce an *Orthis*. This is the course of development in geologic sequence. In *Orthis deflecta* Conrad, sp., there is a deltidium, which in some individuals is large and in others covers but one-half the delthyrium. In mature *O. tricenaria* Conrad and *O. pectinella* Emmons, of the Trenton formation, there is present a small convex deltidium and chilidium which in species of later faunas become nepionic characters and are obsolete during nealogic and ephebolic growth.

The STROPHOMENIDÆ may also have had their origin in some form related to *Billingsella*, but the data are as yet insufficient to establish clearly its line of development.

Orthothetes, Fischer de Waldh. 1837.

Orthis, King 1850 (not Dalman 1828).

Hipparionyx, Vanuxem 1843.

Streptorhynchus, King 1850.

? ?Badiotella, Bittner 1890.

Triplecia, Hall 1859.

Dicraniscus, Meek 1872.

Mimulus, Barrande 1879.

Streptis, Davidson 1881.

Subfamily RAFINESQUINÆ,* n. subfam.

Leptænacea, Braun 1840; Orthisidæ (part), d'Orbigny 1847; Davidsonidæ, King 1850; Strophomeninæ (part), Waagen 1884.

Rafinesquina, Hall 1892.

Leptæna, Dalman 1828.

Leptagonia, McCoy 1844.

Strophomena, Meek 1873 (not Blainville 1825).

Plectambonites, Œhlert 1887 (not Pander 1830).

Stropheodonta, Hall 1850.

Brachyprion, Shaler 1865.

Douvillina, Œhlert 1887.

Leptostrophia, Hall 1892.

Pholidostrophia, Hall 1892.

Strophonella, Hall 1879.

Amphistrophia, Hall 1892.

Leptella, Hall 1892.

Plectambonites, Pander 1830.

Leptæna, Davidson 1853; Œhlert 1877 (not Dalman 1828).

Tropidoleptus, Hall 1859.

? Vitulina, Hall 1861.

Leptænisca, Beecher 1890.

Christiania, Hall 1892.

Davidsonia, Bouchard 1847.

Subfamily CADOMELLINÆ, Munier-Chalmas 1887.

Cadomella, Munier-Chalmas 1887.

Family THECIDIIDÆ,† Gray 1840.

Subfamily THECIDIINÆ, Dall 1870.

Thecidium, Sowerby 1824.

Thecidia, Defrance 1822.

Lacazella, M.-Chalmas 1880.

Thecidiopsis, M.-Chalmas 1887.

Thecidella, M.-Chalmas 1887.

Eudesella, M.-Chalmas 1880.

Pterophloios, Gümbel 1861.

Bactrynium, Emmerich 1855. (In error. Not Bactrillium, Herr.)

Davidsonella, M.-Chalmas 1880.

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*The relative form of the valves in this subfamily, with one exception, *Strophonella*, is the reverse of that in the ORTHOTHETINÆ. The valves are nearly always one convex (ventral), the other concave (dorsal), causing the visceral cavity to be very shallow. The cardinal process is also somewhat differently constructed.

†The THECIDIIDÆ usually are placed with or near the TEREBRATULIDÆ. Beecher has shown (Amer. Jour. Sci., vol. XLIV, p. 141, 1892) that their affinities are with the strophomenoids. There are no calcareous brachial supports nor deltidial plates in *Thecidium*, as are more or less completely developed in all terebratuloids. The characteristic markings of the dorsal valve are homologous with those in *Leptænisca*, *Davidsonia*, and the so-called "reniform markings" of the PRODUCTIDÆ.

Subfamily LYTTONIINÆ, Waagen 1883.

Lyttonia, Waagen 1883.
    Leptodus, Kayser 1882.

Oldhamina, Waagen 1883.

Family PRODUCTIDÆ, Gray 1840.

Productina, Giebel 1846; Chonetinæ and Productinæ, Waagen 1884.

Chonetes, Fischer de Waldh. 1837.
    Leptæna, McCoy 1844 (not Dalman 1828).
Anoplia, Hall 1892.
Chonetella, Waagen 1884.
Chonostrophia, Hall 1892.
Chonetina, Krotow 1888.
    Chonetella, Krotow 1884 (not Waagen 1884).
Daviesiella, Waagen 1884.
Productella, Hall 1867.
Productus, Sowerby 1812.
    Pyxis, Chemnitz 1784.
    Producta, G. B. Sowerby 1825.
    Arbusculites, Murray 1831.
    Protonia, Linck 1830 (not Rafinesque).
    Marginifera, Waagen 1884.
Proboscidella, Œhlert 1887.
Etheridgina, Œhlert 1887.
Chonopectus, Hall 1892.
Strophalosia, King 1844.
    Orthothrix, Geinitz 1847.
    Leptænulosia, King 1845.
Aulosteges, Helmersen 1847.
? ? Aulacorhynchus, Dittmar 1871.
    Isogramma, Meek and W. 1873.

Family RICHTHOFENIDÆ, Waagen 1885.

Richthofenia, Kayser 1881.

Family ORTHIDÆ,* Woodward 1852.

Orthisidæ (part), d'Orbigny 1847; Orthinæ and Enteletinæ, Waagen 1884.

Orthis, Dalman 1828.
    Orthambonites, Pander 1830.
    Plectorthis, Hall 1892.
    Hebertella, Hall 1892.
    Schizophoria, King 1850.
    Orthotichia, Hall 1892.
    Enteletes, Fischer de Wald. 1830.
        Syntrielasma, Meek 1865.
    Dinorthis, Hall 1892.
    Plæsiomys, Hall 1892.
    Orthostrophia, Hall 1883.
    Dalmanella, Hall 1892.
    Heterorthis, Hall 1892.
    Bilobites, Linné 1775.
        Dicœlosia, King 1850.
    Rhipidomella, Œhlert 1890.
        Rhipidomys, Œhlert 1887 (not Wagner.)
    Platystrophia, King 1850.

*It is not intended, by placing the ORTHIDÆ at the end of the order PROTREMATA, to suggest an aberrant development or their derivation from the PRODUCTIDÆ, for it is believed that the orthoid stock had its origin in the BILLINGSELLIDÆ. All orthoids are without the spondylium of the TRULLACEA, and cannot, therefore, be placed in that suborder, while the absence of a deltidium at maturity places the ORTHIDÆ after those families having this plate in all stages of growth. For other observations see note to BILLINGSELLIDÆ.

Order **Telotremata**,* Beecher 1891.

Kampylopegmata (part), Waagen 1883; Pegmatobranchiata (part), Neumayr 1883.

Suborder **Rostracea**,† n. suborder.

Family RHYNCHONELLIDÆ, Gray 1848.

Hypothyridæ (part), King 1850; Rhynchonellinæ, Waagen 1883.

Rhynchotrema, Hall 1860.
Rhynchotreta, Hall 1879.
Uncinulus, Bayle 1878.
Hypothyris, King 1846 (not Phillips 1841).
Stenochisma (Conrad 1839), Hall 1867.
Leiorhynchus, Hall 1860.
Rhynchoporina, Œhlert 1887.
  Rhynchopora, King 1856 (not Illiger and Latreille).
Terebratuloidea, Waagen 1883.
Acanthothyris, d'Orbigny 1850.
Norella, Bittner 1890.
Hemithyris, d'Orbigny 1847.
Peregrinella, Œhlert 1887.
Rhynchonellina, Gemmellaro 1871.
Dimerella, Zittel 1870.
Cryptopora, Jeffreys 1869.
  Atretia, Jeffreys 1876.
  Neatretia, Œhlert 1891.
Rhynchonella, Fischer de Wald. 1809.
  Oxyrhynchus, Llhwyd 1699 (not Aristotle).
  Rhyngonella, Bronn 1849.
  Bicornes, Quenstedt 1851.
  Uncinulina, Bayle 1878.
  Halorella, Bittner 1890.
  Austriella, Bittner 1890.
Eatonia, Hall 1857.
? Branconia, Cagel 1890.

?Family EICHWALDIIDÆ,‡ n. fam.

Eichwaldia, Billings 1858.
  Dictionella, Hall 1867.

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*The TELOTREMATA during nepionic and early nealogic growth have an open triangular fissure or delthyrium in the apex of the ventral valve through which the pedicle emerged. In later nealogic and ephebolic growth, the fissure is more or less closed anteriorly through the development from the mantle of two plates, one from each wall of the delthyrium, which usually coalesce centrally. These plates are known as the "deltidial plates." In such forms as *Cyrtia*, *Cyrtina*, and *Syringothyris*, where the ventral cardinal area is very high, the deltidial plates are anchylosed, the mantle in this region becoming continuous and the plate growing as one piece. The TELOTREMATA, therefore, develop a covering to the delthyrium in an entirely different manner from the other orders during nealogic and ephebolic growth.

†*Rostrum*, a beak. The genera of this suborder are rostrate shells without a spondylium or any calcareons brachial supports other than short or long, straight or slightly curved, freely terminating crura. In the HELICOPEGMATA, the latter consists of two calcareous spiral lamellæ, while in the ANCYLOBRACHIA there is a loop.

‡The genus *Eichwaldia* is very peculiar in not having a distinct articulation of the valves as in other ARTHROPOMATA and further in the Siphonotreta-like pedicle opening. These characters are considered by some writers to indicate affinities with the LYOPOMATA, and it is to this subclass the genus has been doubtfully referred by authors. In *Eichwaldia* there is, however, a method by which articulation takes place consisting of narrow grooves along the lateral edges on the dorsal valve and corresponding ridges or teeth in the ventral.

The writer thinks that *Eichwaldia* had its origin either in the RHYNCHONELLIDÆ or PENTAMERIDÆ, and not directly through any inarticulate phylum; that the peculiar pedicle opening is a modification of the open or closed triangular delthyrium of rostrate species, just as the nepionic circular foramen in *Siphonotreta* becomes changed to an elongate fissure by progressing anteriorly through the shell.

Suborder **Helicopegmata.*** Waagen 1883.

Spiriferacea, Waagen 1883.

Family ATRYPIDÆ,† Dall 1877.

Subfamily ZYGOSPIRINÆ, Waagen 1883.

Anazygidæ (part), Davidson 1884.

Zygospira, Hall 1862.
- Stenocisma, Hall 1847 (not Conrad 1839; Hall 1867).
- Anazyga, Davidson 1882.
- Orthonomæa, Hall 1858.

Glassia, Davidson 1882.

Cœlospira, Hall 1863.
- Leptocœlia, Hall 1857 (not 1859).

Anoplotheca, Sandberger 1856

Subfamily ATRYPINÆ, Waagen 1883.

Atrypa, Dalman 1828.
- Cleiothyris, Phillips 1841 (not King 1850).
- Spirigerina, d'Orbigny 1847.

Grünewaldtia, Tschernyschew 1885.

? Karpinskya, Tsch. 1885.

Family SPIRIFERIDÆ,‡ King 1846 (emend Davidson).

Martiniinæ and Reticulariinæ, Waagen 1883; Spiriferinidæ, Davidson 1884.

1. Subfamily SUESSIINÆ, Waagen 1883.

Cyrtina, Davidson 1858.

Delthyris, Dalman 1828.

Spiriferina, d'Orbigny 1847.

Suessia, Deslongchamps 1854.

Mentzelia, Quenstedt 1871.

1'. Subfamily UNCITINÆ, Waagen 1883.

Uncites, Defrance 1825.

2. Subfamily TRIGONOTRETINÆ, n. subfam.

Delthyrinæ (part), Waagen 1883.

Cyrtia, Dalman 1828.

Syringothyris, Winchell 1863.
- Spirifer, Meek and H. 1864.

Martinia, McCoy 1844.

Spirifer, Sowerby 1815.
- Choristites, Fischer de Wald. 1825.
- Trigonotreta, Koenig 1825; Meek and Hayden 1864.

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*The HELICOPEGMATA are distinguished in having two calcareous, simple or double, spirally enrolled, brachial supports, which may or may not be attached to each other by a variously constructed band or "loop." The direction of the spirals, their connection with the hinge plate and the nature of the loop are considered of prime importance in classifying the genera of this suborder. External characters are not always even of generic value.

†In this family the apices of the brachia are medially or dorsally directed. The loop in the ZYGOSPIRINÆ is a simple connecting band, which in adult ATRYPINÆ is disunited, having free ends. In the ATRYPIDÆ and SPIRIFERIDÆ, the primary lamellæ are straight from their attachment to the crural plate to near the anterior margin, and do not recurve near their point of origin, as in the NUCLEOSPIRIDÆ and ATHYRIDÆ.

‡The SPIRIFERIDÆ are usually much elongated along the hinge line, have posterolaterally directed brachia joined by a V-shaped loop in the SUESSIINÆ and UNCITINÆ, while in the TRIGONOTRETINÆ the loop is obsolescent and consists of two prongs terminating freely, one attached to each primary lamella.

Martiniopsis, Waagen 1883.
Ambocœlia, Hall 1860.
Reticularia, McCoy 1844.
Spiriferus, Blainville 1827.
Spirifera, J. de C. Sowerby 1835.
Brachythyris, McCoy 1844.
Fusella, McCoy 1844.
Hysterolithus, Quenstedt 1871.

Family NUCLEOSPIRIDÆ,* Davidson 1882.

Retziinæ and Dayinæ, Waagen 1883; Anazygidæ (part), Davidson 1884.

Dayia, Davidson 1882.
Hindella, Davidson 1882.
Nucleospira, Hall 1858.
Retzia, King 1850.
Trigeria, Bayle 1878.
Rhynchospira, Hall 1859.
Trematospira, Hall 1857.
Eumetria, Hall 1864.
? **Acambona, White 1862.**
? **Uncinella, Waagen 1883.**

Family ATHYRIDÆ,† Phillips 1841.

1. Subfamily ATHYRINÆ, Waagen 1883.

Meristina, Hall 1867.
Athyris, Davidson 1853 (not McCoy 1844).
Whitfieldia, Davidson 1882.
Bifida, Davidson 1882.
Athyris, McCoy 1844.
Actinoconchus, McCoy 1844.
Spirigera, d'Orbigny 1847.
Euthyris, Quenstedt 1871.
Anomactinella, Bittner 1890.
Cleiothyris, King 1850 (not Phillips 1841).
Seminula, McCoy 1841.
Spirigerella, Waagen 1883.
Dioristella, Bittner 1890.
Amphitomella, Bittner 1890.
Plicigera, Bittner 1890.
Tetractinella, Bittner 1890.
Pentactinella, Bittner 1890.
Kayseria, Davidson 1882.
Diplospirella, Bittner 1890.
Euractinella, Bittner 1890.
Pexidella, Bittner 1890.
Anisactinella, Bittner 1890.

1.′ Subfamily MERISTELLINÆ, Waagen 1883.

Meristella, Hall 1860.
Pentagonia, Cozzens 1846.
Goniocoelia, Hall 1861.
Charionella, Billings 1861.
Merista, Suess 1851.
Camarium, Hall 1859.
? **Clorinda, Barrande 1879.**

*In the NUCLEOSPIRIDÆ and ATHYRIDÆ the brachia are directed laterally. The primary lamellæ are straight but for a short distance from their point of attachment, then bending backward, recurve to form the spiral cones. In the SPIRIFERIDÆ they remain direct.
The apex of the V-shaped loop in the NUCLEOSPIRIDÆ terminates in a more or less long simple process, which may be hooked at its outer end.

†The apex of the V-shaped loop has two processes which, in the ATHYRINÆ, are first short and then become elongated to such an extent that they enter between the first and second revolution of the primary lamellæ of each cone, and in some genera continue to the apex of the brachia. In the MERISTELLINÆ, the two processes of the loop bend upon themselves, return, and join at their point of origin, thus resembling the handles of a pair of scissors.

Family KONINCKINIDÆ, Davidson 1853.

Koninckininæ and Amphiclininæ, Waagen 1883; Diplospidæ and Diplospiridæ, Munier-Chalmas 1880.

Koninckina, Suess 1853.
Amphiclina, Laube 1865.
Koninckella, M.-Chalmas 1880.
? Thecospira, Zugmeyer 1880.
? Amphiclinodonta, Bittner 1890.

Suborder **ANCYLOBRACHIA**,* Gray 1848 (Emend).

Ancylopoda and Cryptobrachia (part), Gray 1848; Kampylopegmata and Terebratulacea, Waagen 1883.

Family TEREBRATULIDÆ, Gray 1840.

Subfamily CENTRONELLINÆ, Waagen 1882.

Meganterinæ, Waagen 1882.

Hallina, Winchell and Schuchert 1892.
Rensselaeria, Hall 1859.
Newberria, Hall 1891.
  Rensselandia, Hall 1867.
Meganteris, Suess 1856.
Centronella, Billings 1859.
  Cryptonella, Hall 1863 (not 1861, 1867.)
Cryptonella, Hall (1861?) 1867.
Juvavella, Bittner 1888.
Nucleatula (Zugmayer) Bittner 1890.
? Notothyris, Waagen 1882.

Subfamily STRINGOCEPHALINÆ, Dall 1870.

Stringocephalidæ, King 1850; Davidson 1853.

Stringocephalus, Defrance 1827.
? Cryptocanthia, White and St. John 1868.

Subfamily TEREBRATULINÆ, Dall 1870.

Dielasma, King 1850.
  Epithyris, King 1850 (not Phillips 1841).
  Seminula, McCoy 1855 (not 1844).
Dielasmina, Waagen 1882.
Terebratula, Llhwyd 1699.
  Sacculus, Llhwyd 1699.
  Lampas, Meuschen 1787.
Glossothyris, Douville 1880.
Pygope, Link 1830.
  Diphyites, Schröter 1799.
  Pugites, de Hann 1833.
  Antinomia, Catullo 1850.
? Propygope, Bittner 1890.
Liothyrina, Œhlert 1887.
  Epithyris, Desl. 1862 (not King 1848).

*This suborder is characterized by having a calcareous loop for the support of the brachia. Some authors have regarded the length of the loop as of subfamily importance, but this the writer does not consider as of great value in classification. The work of Friele, Deslongchamps, Davidson, Fischer and Œhlert and others, has shown that in certain forms the loop passes through various stages of growth, or metamorphoses. In another set of genera, the TERABRATULIDÆ, the loop does not pass through any transitional stages. Upon this basis the genera have been arranged tentatively by Dr. Beecher and the writer. However, much yet remains to be worked out regarding the loop and the dental and septal plates in the fossil forms, before any permanent classification of the genera into families is possible. Geratology has also been taken into account, as a number of genera have partially or entirely lost their brachial supports.

Terebratularius, Dumeril 1806.
Nucleata, Quenstedt 1871.
Musculus, Quenstedt 1871 (not Klein 1753.)
Hemiptychina, Waagen 1882.
Rhætina, Waagen 1882.
Zugmeyeria, Waagen 1882.
Dictyothyris, Douville 1880.
Gryphus, Megerle 1811 (not Brisson 1760).
Liothyris, Douville 1880 (not Conrad 1875).
Terebratulina, d'Orbigny 1847.
Eucalathis, Fischer and Œhlert 1890.
Agulhasia, King 1871.
Disculina, Deslongchamps 1884.

Family ? DYSCOLIIDÆ, Fischer and Œhlert 1892.

Dyscolia, Fischer and Œhlert 1890.

Family TEREBRATELLIDÆ, King (Emend Beecher 1893).

Waldheimidæ, Douville, 1880; Waldheimiinae, Waagen 1882.

Subfamily DALLININÆ, n. subf. Beecher.

Dallina, n. gen. Beecher. Type *Waldheimia septigera* Lovén.
Macandrevia, King 1859.

Lacqueus, Dall 1870.
Frenula, Dall 1871.
Ismenia, King 1850 (not Dall 1871).
Kingina, Davidson 1852.
Kingia, Schoenbach 1867.
Lyra, Cumberland 1816.
Terebrirostra, d'Orbigny 1847
Trigonosemus, Koenig 1825.
Fissurirostra, d'Orbigny 1847.
Fissirostra, d'Orbigny 1848.
Delthyridea, King 1850.
Flabellothyris, Deslong. 1884.
Eudesia, King 1850.
Orthotoma, Quenstedt 1871.
Trigonella, Quenstedt 1871.
Zeilleria, Bayle 1878.
Fimbriothyris, Deslong. 1884.
Ornithella, Deslong. 1884.
Microthyris, Deslong. 1884.
Aulacothyris, Douville 1880.
Camerothyris, Bittner 1890.
Epicyrta, Deslong. 1884.
Cincta, Quenstedt 1871.
Antiptychina, Zittel 1883.
Plesiothyris, Douville 1880.
? Hynniphoria, Suess 1858.
? Cruratula, Bittner 1890.
? Orthoidea, Friren 1875.

Subfamily, PLATIDIINÆ, Dall 1870.

Platidia, Costa 1852.
Morrisia, Davidson 1852.

Subfamily MEGATHYRINÆ, Dall 1870.

Argiopidæ, King 1850; Megathyridæ, Œhlert 1887; Argiopidæ, Davidson 1884; Argiopinæ, Davidson 1887.

Megathyris, d'Orbigny 1847.
  Argiope, Deslongchamps 1842 (not Savigny and Audouin 1827).
Cistella, Gray 1850.

Zellania, Moore 1854.
Gwynia, King 1859.

Subfamily MAGELLANINÆ, n. subf. Beecher.

Waldheimidæ (part), Douville, 1880; Terebratellinæ, Davidson.

Magellania, Bayle 1880.
  Waldheimia, King 1850 (not Brulle 1846).
Terebratella, d'Orbigny 1847.
  Delthyris, Menke 1830 (not Dalman 1828).
  Ismenia, King 1850 (not Dall 1870).
  Waltonia, Davidson 1850.
  Magasella, Dall 1870.

Neothyris, Douville 1880.
Cœnothyris, Douville 1880.

Subfamily MAGASINÆ, Davidson 1887.

Magasidæ (part), d'Orbigny 1847, King 1850; Rhynchoridæ (part), King 1850; Muhlfeldtinæ, Œhlert 1887.

Magas, Sowerby 1816.
Bouchardia, Davidson 1849.
  Pachyrhynchus, King 1850.
Muhlfeldtia, Bayle 1880.
  Megerlia, King 1850 (not Robineau Desvoidy 1830).

Mannia, Dewalque 1874.
Rhynchorinæ, Œhlert 1887.
? Rhynchora, Dalman 1828.

Subfamily KRAUSSININÆ, Dall 1870.

Kraussidæ (part), Davidson 1870.

Kraussina, Davidson 1859.
  Kraussia, Davidson 1852 (not Dana 1852).

Megerlina, Deslongchamps 1884.

GEOLOGICAL DISTRIBUTION OF THE BRACHIOPODA.

	PALÆOZOIC.					MESOZOIC.			CÆNOZOIC.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Fam. PATERINIDÆ.	—										
Paterina, Beecher.	—										
Fam. OBOLIDÆ.	—	—									
Obolella, Billings.	—										
Elkania, Ford.	—										
Neobolus, Waagen.	—										
Obolus, Eichwald.	—	—									
? Spondylobolus, McCoy.		—									
Fam. TRIMERELLIDÆ.	—	—	—								
? Lakmina, Œhlert.	—										
Dinobolus, Hall.		—	—								
Monomorella, Billings.			—								
Trimerella, Billings.			—								
Rhynobolus, Hall.			—								
Fam. LINGULELLIDÆ.	—	—									
Lingulella, Salter.	—										
Lingulepis, Hall.	—										
Leptobolus, Hall.		—									
Paterula, Barrande.		—									
? Mickwitzia, Schmidt.	—										
Fam. LINGULIDÆ.		—	—	—	—	—	—	—	—	—	—
Lingula, Bruguière.		—	—	—	—	—	—	—	—	—	—
Glossina, Phillips.		—	—	—	—						
Dignomia, Hall.				—							
Glottidia, Dall.											—
Barroisella, Hall.				—							
Thomasina, Hall.		—									
Fam. LINGULASMATIDÆ.		—	—								
Lingulops, Hall.		—	—								
Lingulasma, Ulrich.		—									
Fam. TREMATIDÆ.	—	—	—	—	—						
Discinolepis, Waagen.	—										
Trematis, Sharpe.		—									
Schizocrania, Hall & Whitf.		—	—	—							
Schizobolus, Ulrich.				—							
Œhlertella, Hall.					—						
? Monobolina, Salter.		—									
Fam. DISCINIDÆ.		—	—	—	—	—	—	—	—	—	—
Orbiculoidea, d'Orbigny.		—	—	—	—	—	—	—			
Schizotreta, Kutorga.		—	—								
Lindstrœmella, Hall.				—							
Rœmerella, Hall.				—							
Discina, Lamarck.										—	—
Discinisca, Dall.										—	—
Fam. ACROTRETIDÆ.	—	—									
Iphidea, Billings.	—										
Acrothele, Linnarsson.	—										
Linnarssonia, Walcott.	—										
Discinopsis (Matthew), Hall.	—										
Acrotreta, Kutorga.	—	—									
Conotreta, Walcott.		—									

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Rhipidomella, Œhlert.			—	—	—						
Platystrophia, King.		—	—								
Fam. Rhynchonellidæ.	—	—	—	—	—	—	—	—	—	—	—
Rhynchotrema, Hall.		—									
Rhynchotreta, Hall.			—								
Uncinulus, Bayle.			—	—							
Hypothyris, King.				—							
Stenochisima, Conrad.				—							
Leiorhynchus, Hall.				—							
Rhynchoporina, Œhlert.					—						
Terebratuloidea, Waagen.					—						
Rhynchonella, Fischer de Wald.		?	?	?	?	—	—	—	—	—	—
Austriella, Bittner.						—	—				
Acanthothyris, d'Orbigny.							—				
Norella, Bittner.						—					
Hemithyris, d'Orbigny.										—	—
Peregrinella, Œhlert.								—			
Rhynchonellina, Gemmellaro.							—				
Dimerella, Zittel.						—					
Cryptopora, Jeffreys.											—
Eatonia, Hall.			—	—							
? Branconia, Cagel.				—							
Fam. Eichwaldiidæ.		—	—								
Eichwaldia, Billings.		—	—								
Fam. Atrypidæ.		—	—	—							
Subfam. Zygospirinæ.		—	—	—							
Zygospira, Hall.		—									
Glassia, Davidson.			—								
Cœlospira, Hall.			—	—							
Anoplotheca, Sandberger.				—							
Subfam. Atrypinæ.			—	—							
Atrypa, Dalman.			—	—							
Grunewaldtia, Tschernyschew.				—							
? Karpinskya, Tsch.				—							
Fam. Spiriferidæ.			—	—	—	—	—				
Subfam. Suessiinæ.			—	—	—	—	—				
Cyrtina, Davidson.				—	?	—					
Delthyris, Dalman.			—	—							
Spiriferina, d'Orbigny.					—	—	—				
Suessia, Deslongchamps.							—				
Mentzelia, Quenstedt.							—				
Subfam. Uncitinæ.				—							
Uncites, Defrance.				—							
Subfam. Trigonotretinæ.			—	—	—						
Cyrtia, Dalman.			—								
Syringothyris, Winchell.				?	—						
Martinia, McCoy.				—	—	?					
Martiniopsis, Waagen.					—	?					
Ambocœlia, Hall.				—							
Reticularia, McCoy.			—	—	—						
Spirifer, Sowerby.			—	—	—						
Fam. Nucleospiridæ.			—	—	—						
Davia, Davidson.			—								
Hindella, Davidson.			—								

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary	Recent.
Nucleospira, Hall.			—	—	?	?	The Triassic forms belong to other genera.				
Retzia, King.				—							
Rhynchospira, Hall.			—	—							
Trematospira, Hall.			—	—							
Eumetria, Hall.					—						
? Acambona, White.					—						
? Uncinella, Waagen.					—						
Fam. Athyridæ.			—	—	—	—					
Subfam. Athyrinæ.			—	—	—	—					
Meristina, Hall.			—								
Bifida, Davidson.				—							
Athyris, McCoy.				—	—	—					
Cleiothyris, King.					—	?					
Seminula, McCoy.					—						
Spirigerella, Waagen.					—						
Dioristella, Bittner.						—					
Amphitomella, Bittner.						—					
Plicigera, Bittner.						—					
Kayseria, Davidson.				—							
Diplospirella, Bittner.						—					
Pexidella, Bittner.						—					
Anisactinella, Bittner.						—					
Subfam. Meristellinæ.			—	—							
Meristella, Hall.				—							
Pentagonia, Cozzens.				—							
Charionella, Billings.				—							
Merista, Suess.			—	—							
? Clorinda, Barrande.			—								
Fam. Koninckinidæ.						—	—				
Koninckina, Suess.						—					
Amphiclina, Laube.						—					
Koninckella, M.-Chalmas.						—					
? Thecospira, Zugmeyer.						—	—				
? Amphiclinodonta, Bittner.						—					
Fam. Terebratulidæ.		—	—	—	—	—	—	—	—	—	—
Subfam. Centronellinæ.		—	—	—	—	—					
Hallina, Winchell and Schuchert.		—									
Rensselæria, Hall.				—							
Newberria, Hall.			—	—							
Meganteris, Suess.				—							
Centronella, Billings.				—							
Cryptonella, Hall.				—							
Juvavella, Bittner.						—					
Nucleatula (Zugmeyer), Bittner.						—					
? Notothyris, Waagen.					—						
Subfam. Stringocephalinæ.				—	—						
Stringocephalus, Defrance.				—							
? Cryptacanthia, White and St. John.					—						
Subfam. Terebratulinæ.					—	—	—	—	—	—	—
Dielasma, King.					—						
Dielasmina, Waagen.					—						
Terebratula, Llhwyd.				?	—	—	—	—	—		
Hemiptychina, Waagen.					—	—	—	—			
Rhætina, Waagen.						—					
Zugmeyeria, Waagen.						—					
Dictyothyris, Douville.							—	—			
Glossothyris, Douville.							—	—			

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Rhipidomella, Œhlert.			—	—	—						
Platystrophia, King.		—	—								
Fam. Rhynchonellidæ.	—	—	—	—	—	—	—	—	—	—	—
Rhynchotrema, Hall.		—									
Rhynchotreta, Hall.			—								
Uncinulus, Bayle.			—	—							
Hypothyris, King.				—							
Stenochisima, Conrad.				—							
Leiorhynchus, Hall.				—							
Rhynchoporina, Œhlert.					—						
Terebratuloidea, Waagen.					—						
Rhynchonella, Fischer de Wald.		?	?	?	?	—	—	—	—	—	—
Austriella, Bittner.						—	—				
Acanthothyris, d'Orbigny.							—				
Norella, Bittner.						—					
Hemithyris, d'Orbigny.										—	—
Peregrinella, Œhlert.								—			
Rhynchonellina, Gemmellaro.							—				
Dimerella, Zittel.						—					
Cryptopora, Jeffreys.											—
Eatonia, Hall.			—	—							
? Branconia, Cagel.				—							
Fam. Eichwaldiidæ.		—	—								
Eichwaldia, Billings.		—	—								
Fam. Atrypidæ.		—	—	—							
Subfam. Zygospirinæ.		—	—	—							
Zygospira, Hall.		—									
Glassia, Davidson.			—								
Cœlospira, Hall.			—	—							
Anoplotheca, Sandberger.				—							
Subfam. Atrypinæ.			—	—							
Atrypa, Dalman.			—	—							
Grunewaldtia, Tschernyschew.				—							
? Karpinskya, Tsch.				—							
Fam. Spiriferidæ.			—	—	—	—	—				
Subfam. Suessinæ.			—	—	—	—	—				
Cyrtina, Davidson.				—	?	—					
Delthyris, Dalman.			—	—							
Spiriferina, d'Orbigny.					—	—	—				
Suessia, Deslongchamps.							—				
Mentzelia, Quenstedt.							—				
Subfam. Uncitinæ.				—							
Uncites, Defrance.				—							
Subfam. Trigonotretinæ.			—	—	—						
Cyrtia, Dalman.			—								
Syringothyris, Winchell.				?	—						
Martinia, McCoy.				—	—	?					
Martiniopsis, Waagen.					—	?					
Ambocœlia, Hall.				—							
Reticularia, McCoy.			—	—	—						
Spirifer, Sowerby.			—	—	—						
Fam. Nucleospiridæ.			—	—	—						
Dayia, Davidson.			—								
Hindella, Davidson.			—								

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quaternary.	Recent.
Nucleospira, Hall.			—	—	?	?	The Triassic forms belong to other genera.				
Retzia, King.				—							
Rhynchospira, Hall.			—	—							
Trematospira, Hall.			—	—							
Eumetria, Hall.					—						
? Acambona, White.					—						
? Uncinella, Waagen.					—						
Fam. Athyridæ.			—	—	—	—					
Subfam. Athyrinæ.			—	—	—	—					
Meristina, Hall.			—								
Bifida, Davidson.				—							
Athyris, McCoy.				—	—	—					
Cleiothyris, King.					—	?					
Seminula, McCoy.					—						
Spirigerella, Waagen.					—						
Dioristella, Bittner.						—					
Amphitomella, Bittner.						—					
Plicigera, Bittner.						—					
Kayseria, Davidson.				—							
Diplospirella, Bittner.						—					
Pexidella, Bittner.						—					
Anisactinella, Bittner.						—					
Subfam. Meristellinæ.			—	—							
Meristella, Hall.				—							
Pentagonia, Cozzens.				—							
Charionella, Billings.				—							
Merista, Suess.			—	—							
? Clorinda, Barrande.			—								
Fam. Koninckinidæ.						—	—				
Koninckina, Suess.						—					
Amphiclina, Laube.						—					
Koninckella, M.-Chalmas.						—	—				
? Thecospira, Zugmeyer.						—					
? Amphiclinodonta, Bittner.						—					
Fam. Terebratulidæ.		—	—	—	—	—	—	—	—	—	—
Subfam. Centronellinæ.		—	—	—	—	—					
Hallina, Winchell and Schuchert.		—									
Rensselæria, Hall.				—							
Newberria, Hall.			—	—							
Meganteris, Suess.				—							
Centronella, Billings.				—							
Cryptonella, Hall.				—							
Juvavella, Bittner.						—					
Nucleatula (Zugmeyer), Bittner.						—					
? Notothyris, Waagen.					—						
Subfam. Stringocephalinæ.				—	—						
Stringocephalus, Defrance.				—							
? Cryptacanthia, White and St. John.					—						
Subfam. Terebratulinæ.					—	—	—	—	—	—	—
Dielasma, King.					—						
Dielasmina, Waagen.					—						
Terebratula, Llhwyd.				?	—	—	—	—	—		
Hemiptychina, Waagen.					—	—	—	—			
Rhætina, Waagen.						—					
Zugmeyeria, Waagen.						—					
Dictyothyris, Douvillé.							—	—			
Glossothyris, Douvillé.							—	—			

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
Pygope, Link.							—	—			
? Propygope, Bittner.							—				
Liothyrina, Œhlert.										—	—
Terebratulina, d'Orbigny.							—	—	—	—	—
Eucalathis, F. and O.											—
Agulhasia, King.								—	—	—	—
Disculina, Deslongchamps.							—				
Fam. Dyscoliidæ.											—
Dyscolia, Fischer and Œhlert.											—
Fam. Terebratellidæ.							—	—	—	—	—
Subfam. Dallininæ.							—	—	—	—	—
Dallina, Beecher.											—
Macandrevia, King.											—
Eudesia, King.							—				
Lacqueus, Dall.											—
Ismenia, King.							—				
Kingina, Davidson.								—			
Lyra, Cumberland.							—	—			
Trigonosemus, Koenig.							—	—			
Flabellothyris, Deslongchamps.							—	—			
Zeilleria, Bayle.						—	—	—	—	—	
Fimbriothyris, Deslong.									—		
Ornithella, Deslong.							—	—			
Microthyris, Deslong.							—				
Aulacothyris, Douville.							—	—			
Camerothyris, Bittner.						—	—				
Epicyrta, Deslong.							—				
Cincta, Quenstedt.							—				
Antiptychina, Zittel.							—	—			
Plesiothyris, Douville.							—	—			
? Hynniphoria, Suess.						—	—				
? Cruratula, Bittner.											
? Orthoidea, Friren.							—				
Subfamily Platidiinæ.											—
Platidia, Costa.											—
Subfam. Megathyrinæ.							—	—	—	—	—
Megathyris, d'Orbigny.							—	—	—		
Cistella, Gray.								—	—	—	—
Zellania, Moore.							—				
Gwynia, King.										—	—
Subfam. Magellaninæ.									—	—	—
Magellania, Bayle.										—	—
Neothyris, Douville.									—	—	—
Terebratella, d'Orbigny.							—	—	—	—	—
Coenothyris, Douville.							—				
Subfam. Magasinæ.								—	—	—	—
Magas, Sowerby.								—			
Bouchardia, Davidson.											—
Muhlfeldtia, Bayle.											—
Manuia, Dewalque.							?	—	—	—	—
Rhynchorinæ, Œhlert.								—		—	

	Palæozoic.					Mesozoic.			Cænozoic.		
	Primordial.	Lower Silurian.	Silurian.	Devonian.	Permian and Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Tertiary.	Quarternary.	Recent.
?Rhynchora, Dalman.								—			
Subfam. Kraussininæ.											—
Kraussina, Davidson.											—
Megerlina, Deslongchamps.											—
Number of genera appearing in each system.	22	47	41	40	36	24	35	10	1	7	11
			186				72			21	
Genera occurring in a system.	22	51	63	71	51	32	45	32	14	16	27
Genera restricted to one system.	18	24	20	35	33	21	21	7	0	1	11
Number of genera derived from preceding systems.		4	23	29	15	7	9	20	13	11	16
Number of genera passing from one period to the next above it.							7			13	

[Palæontological Notes from Buchtel College, No. 3.]

A NEW COCCOSTEAN—COCCOSTEUS CUYAHOGÆ.

By E. W. Claypole, Akron, O.

Figs. 1 and 2.

The "Old Red Sandstone" of Scotland furnished Hugh Miller with the original fossils on which the name *Coccosteus* was placed, and for which his now classic description was drawn up. He recognized several species but these have since been reduced to two by merging several into his first and chief form *C. decipiens* which, with *C. minor*, comprises probably all that he discovered.

Since his time, however, others have been brought to light but as these are not all described from the same plate or part of the skeleton it is scarcely possible at present to correlate them.

The structure of the genus is however fairly well understood so that little doubt exists concerning the position and relation of the various plates of the head and body. But of a few minor features and of the difference between the species in matters of detail much yet remains to be learned.

FIG. 1

The forms recognized by Mr. A. S. Woodward in his recent catalogue are as follows:

Coccosteus decipiens Ag., 1844.
Lower Old Red Sandstone.
Coccosteus minor H. Miller, 1858.
Lower Old Red Sandstone.
Coccosteus hercynius H. v. Meyer, 1852.
Lower Devonian.
Coccosteus disjectus A. S. Woodward, 1891.
Upper Old Red Sandstone.
Coccosteus obtusus H. Trautschold, 1889.
Devonian.
Coccosteus occidentalis Newberry, 1875.
Lower Devonian (Corniferous).

Besides these there are several insufficiently described or uncertain fragments referred hither by different authors.

Yet another species was described in 1889 by Whiteaves as *Coccosteus acadicus* from the Lower Devonian of Campbellton, New Brunswick.

There are therefore at least five species known from Europe and two from North America.

The fishes of this genus are not large, the original *C. decipiens* measuring only about sixteen inches in length and its jaw, as figured by Miller, in "The Old Red Sandstone" is scarcely two inches long. Nor were any of the rest of larger size. The two American species whose jaws are unknown can be estimated by the dorsal plates which vary but little in length from those of *C. decipiens*. Of *C. acadicus* numerous specimens have been found showing both dorsal and ventral surfaces and these have been fully illustrated by Mr. Whiteaves, the palæontologist to the Geological Survey of Canada, in his "Illustrations of the Devonian Fishes of Canada." Of *C. occidentalis* only two plates are known—the medio-dorsal and the medio-lateral—and these were found by the late Mr. J. H. Klippart, of Columbus, Ohio, in the Corniferous limestone of Delaware, O. No reasonable

doubt can exist concerning their nature, though of the latter only the inner face is exposed.

If as Dr. Newberry has suggested (See Pal. of Ohio, p. 306, vol. 1) the jaw there described as *Liognathus spathulatus* really belongs to *C. occidentalis* (a suspicion not yet proved) we shall be in a position to compare it with the jaw of *C. decipiens* with which in size it exactly corresponds, though differing widely in the dentition. In this character it more nearly approaches the dinichthyid pattern. Possibly, however, this connection if proved may have the effect of removing *C. occidentalis* from its present generic position rather than that of introducing *Liognathus*.

FIG. 2

Coccosteus thus ranges through the Devonian in both continents, *C. hercynius* and *C. occidentalis* coming from the lower and all the other species from the upper strata.

It is therefore of not a little interest to record the occurrence of *Coccosteus* at another and a higher horizon in Ohio. The specimen is remarkable also for its large size, far exceeding any of those already known. It was found by the veteran collector, Dr. W. Clark, of Berea, O., in the Cleveland shale near that town and close to the horizon which has yielded *Dinichthys* and the other armor-clad fishes with which palæontologists are now familiar.

The fossil is the left ramus of the lower jaw and measures five and a half inches in length. Some part of the spatulate end is missing and at least another half inch must be added to complete it. Obviously therefore it belonged to a coccostean far surpassing in size any of the rest. If we assume that the jaw was only six inches long it was then at least three times as large as that of *C. decipiens* or nearly four feet from nose to tail, and was a very giant among its fellows.

At the same time, as may be seen at once by consulting the figures, no doubt regarding its affinity can be entertained. There are the mandibular teeth, eight in number, on the upper edge of the mandible just in front of the middle, less sharp and regular than represented by Hugh Miller but not less characteristic. In front are the symphysial teeth (or rather their bases for the teeth themselves have been broken off) projecting inward toward those on the opposite ramus. These are three in number. H. Miller

speaks of five but figures six in *C. decipiens* and they appear to vary from three to eight in different species. They are shown in the smaller figure (2) which is a view of the inner front edge of the mandible fortunately exposed on the very edge of the slab of shale and carrying the three bases of the symphysial teeth with great distinctness.

It would be useless here to enter on a discussion of the mode of using this peculiar dentition, unparalleled in the animal kingdom and only approached by that of *Onychodus* and *Diplognathus* (and perhaps *Liognathus*). The vertical row of teeth on the edge of the jaw led H. Miller to his conclusion that *Coccosteus* united the dentition of a beetle or some similar invertebrate to the general structure of a vertebrate animal. This conclusion was the more pardonable because in his early specimens the teeth on the ramus of the jaw were missing. Subsequent discoveries led the illustrious Scotchman to modify, though scarcely to abandon, his first conclusion and to leave the structure of this anomalous mouth as a puzzle to his successors, which it remains to this day.

It is just possible, though I am not aware that any specimen yet found bears out the supposition, that the two mandibles of *Coccosteus* did not close on each other so as to form a sutural union. In fact the presence of these symphysial teeth almost renders this structure necessary. We now know that in some kindred forms, such as *Dinichthys*, there were intermandibular teeth which met and fitted against similar intermaxillary teeth in the upper jaw. If some similar arrangement existed in *Coccosteus* holding the two rami assunder at a small distance, opportunity would be afforded for the employment of the projecting symphysial teeth. The small size of all the previously known species may account for the non-discovery of such a plate even if it existed.

It may be that the tooth-bearing bone of *Onychodus* lends some countenance to this suggestion but failing its actual production we can only at present speculate on the possibilities in the case of *Coccosteus*. Whatever may be the ultimate solution of this anatomical enigma it seems impossible that the symphysis of *Coccosteus* can have been a close one.

For this new species is proposed the name of *Coccosteus cuyahoga*, connecting it with the region in which it was discovered by Dr. Clark.

It comes from one of the lowest beds of the Cleveland shale, a horizon which has thus far yielded only an as yet undescribed species of *Titanichthys*.

Some other fragments are also in the hands of Dr. Clark but cannot at present be described. The chief of them is a much broken plate, apparently dorso-medial, which corresponds in size to what would be expected, being about three times as large as the similar plate of *C. decipiens*. These, however, must await further discoveries.

PLEISTOCENE PAPERS READ AT THE OTTAWA MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA.

Among the papers read and discussed at the recent meeting of the Geological Society of America in Ottawa, Canada, December 28, 29, and 30, 1892, the following related to the glacial drift and history of the Pleistocene period.

Distinct glacial epochs, and the criteria for their recognition. By R. D. SALISBURY. The question concerning how much decrease and ensuing re-advance of ice-sheets should constitute an interglacial epoch is to be answered by (*a*) the distance of the glacial recession, (*b*) the length or shortness of the time between successive advances of the ice, (*c*) climatic changes in the area of the oscillations, and (*d*) intervening geologic changes or movements of uplift or depression of the land.

The criteria for discrimination of ice invasions so distinct as to be properly called separate epochs were considered under the following heads:

1. Forest beds intercalated between deposits of till. These do not necessarily indicate truly interglacial conditions, but are to be so interpreted if their species belong to a temperate climate or to one as warm as now in the same locality, also if they have a great geographic extent.

2. Bones of land animals fossil in strata with till beneath and above.

3. Lacustrine or marine fossiliferous beds underlain and overlain by till, if they denote a climate as temperate or mild as now.

4. Beds of subaërially deposited glacial gravel and sand, with till above them. These can seldom be shown to have sufficient extent to prove an interglacial epoch, but are corroborative when occurring with other evidences.

5. Differential weathering, which is dependent on length of time and warmth of climate. If a former land surface of glacial drift deeply weathered has a great northward extent under a later sheet of till, it is acceptable proof of an interglacial epoch; but the preservation of such a soil layer would be fragmentary and local. On many tracts the erosion by the later ice invasion wholly removed the interglacial soil and stratified deposits, with their fossils and forest bed.

6. Different amounts of subaërial erosion on areas of the older and newer drift. On some tracts of the former it appears to be ten times more than of the latter.

7. Valleys excavated between successive depositions of till. These are especially important if eroded in rock, and most so when far inside the limits of the newer drift.

8. Successive different directions of the ice movement on the same ground, as shown by striæ and transportation of drift. Within any single epoch of glaciation gradual changes in direction of the glacial currents were produced by variations in the extent and thickness of the ice and especially by its unequal and irregular melting during its stages of retreat; but where the changes were abrupt they indicate distinct epochs.

9. Varying altitudes and slopes of the land. If a tract like the basin of the Mississippi river was at one time in the Ice age low and afterward much higher, it would imply a long intervening time; and if the record of this change as shown by the glacial deposits seems sudden, this would probably be due to an interglacial epoch.

10. Vigor and sluggishness of ice action. During the time of maximum extent of the glaciation in the Mississippi basin the action was sluggish, but afterward was vigorous when the moraines of retrocession were accumulated.

Some of these criteria may be sufficient singly to prove distinct glacial epochs; but when several or nearly all of them furnish concurrent testimony of such epochs, they seem equivalent to a mathematical demonstration.

In the discussion of this paper, Prof. G. FREDERICK WRIGHT

referred to the observations of Torell, Holst, and others, on the exposure of the englacial and superglacial till to full oxidation and weathering, while the subglacial till was protected by its position beneath the ice. The larger amount of erosion of the outer and older portions of the drift sheet seems attributable to its longer exposure where the drainage from the waning ice-sheet passed over it.

Mr. W J McGee would add, as another criterion of an interglacial epoch, difference in the origin and size of boulders in the older and newer drift, as in northeastern Iowa. Nodules of bog iron ore in the Iowa forest bed, implying a long interval of forest growth, are striated by the succeeding ice incursion.

Prof. C. H. Hitchcock remarked that the amount of oscillation of the ice-front to be ranked as a division between glacial epochs must be a difficult question to be determined by every glacialist according to his own judgment, unless it can be shown that the ice-sheet was almost or entirely melted away and afterward was anew accumulated. In New England and the eastern provinces of Canada probably as many terminal moraines are recognizable as in the upper Mississippi region, but these all in both regions seem referable to stages of slight interruption in the decline of a single ice-sheet. No support for an interglacial epoch is found in fossiliferous marine beds between deposits of till on our Atlantic coast, for such beds are absent, excepting where, as at Portland, Me., and St. John, N. B., they imply only a moderate re-advance of the ice interrupting its general departure. Stream erosion during the Ice age may have proceeded very rapidly where the land was much higher than now.

Mr. Warren Upham, referring to the first three of Prof. Salisbury's criteria, thought that the rapidity of departure of the ice-sheet, as shown by the eskers, associated plains and plateaus of gravel and sand, and the valley drift, implies for the closing stage of the Glacial period fully as warm summers close to the border of the retreating ice as at the present time in the same latitudes. Therefore a temperate flora and fauna would exist near the retreating ice. But the terminal moraines show that at various times the general glacial retreat was interrupted by secular changes in the climatic conditions bringing increased snowfall and a halt or re-advance of the ice. If at such times it advanced only a few miles, the fossils of the beds covered by the later till

would include temperate species of forest trees, of land animals, and of mollusca where the ice pushed into lakes or the sea.

Changes in the altitude and slopes of the land, shown by successive moraines and the accompanying gravel, sand, and silt deposits, which Prof. Salisbury would regard as evidence of successive glacial epochs, may have taken place within a few hundred years, as the area of the glacial lake Agassiz was differentially uplifted, to a maximum of 400 feet or more, during the departure of the ice-sheet from that area, which yet appears to have occupied only about 1,000 years.

Croll's astronomic theory of the cause of the Ice age has led glacialists both in Europe and America to search for evidences of successive glacial and interglacial epochs; but the recency of the final departure of the ice-sheets, besides other arguments, shows that this theory is untenable, although it has been exceedingly useful in leading to careful and widely extended observations. It now therefore seems more probable that the Ice age was a period of continuous glaciation, with moderate fluctuations of the boundaries of the ice-sheets during both their general growth and decline.

Dr. ROBERT BELL spoke of layers of peat and lignite between deposits of till on the Nissinaibi and Kenogami rivers, tributary to James bay, while loose fragments of lignite probably derived from similar layers, are found on the Albany and Churchill rivers. It may be doubted, however, whether the successive ice incursions should be regarded as distinct epochs, since the several boundaries of the ice-sheets, shown by the limits of the diverse drift sheets and courses of the terminal moraines, are nearly parallel with each other.

Prof. B. K. EMERSON noted the general absence of indications of interglacial conditions in New England, excepting very slight oscillations of the ice-border during its retreat, such as at one locality in the Connecticut valley gave three successive deposits of till with intercalated clays containing fossil leaves of subarctic plants.

Professor SALISBURY, in closing the discussion, objected to arguments on this subject based on studies of the regions covered and much eroded by the latest glaciation, as New England and the greater part of Canada. The proper areas for the discrimination of these epochs lie along the borders of the drift sheet. Im-

portant changes of altitude, even though they may have taken place in a short time, seem sufficient for discrimination of distinct epochs, but these are proved by concurrence of all the criteria cited.

Pleistocene phenomena in the region southeast and east of Lake Athabasca, Canada. By J. B. TYRRELL. This paper described a large region extending from lake Athabasca to Cree, Hatchet, and Reindeer lakes. The striation ranges mainly from southwest to due west, being nearly at right angles with the south-southeastward and southward striation of the vicinity of Winnipeg and lake Manitoba. On the Archæan gneissic and granitic rocks till is usually scanty, but on the contiguous tracts of sandstone it occurs in larger amount and is sometimes amassed in plentiful and prominent drumlins. One of the most noteworthy areas of drumlins is crossed by the outlet from Hatchet lake to lake Athabasca, and another is the district of Cree lake. Many typically oval and steep drumlins rise as islands in Cree lake to hights of 100 to 200 feet and are surrounded by water 70 feet deep near their bases. Eskers are also well developed in various parts of this region, together with plateaus and plains of gravel and sand, deserted river channels, and beaches of glacial lakes 150 feet or more above the existing lakes.

In discussion, Prof. HITCHCOCK asked whether all the striæ observed about lake Manitoba run south-southeasterly and southerly, to which Mr. TYRRELL replied in the affirmative.

Prof. WRIGHT inquired whether the Laurentian boulders of Assiniboia and Alberta were brought across the region of lakes Winnipeg and Manitoba. Mr. TYRRELL answered that more probably they were brought from portions of the Archæan belt farther northwest, as about Reindeer and Athabasca lakes.

Mr. UPHAM remarked that the occurrence of the drumlins only on limited tracts, while the greater part of the country explored had none, is like their distribution in the regions where they had been described previously in northwestern Manitoba, the northern United States, and southern New Brunswick.

Dr. BELL directed attention to an early southwestward glaciation of the Reindeer lake and Athabascan region, by which the Laurentian boulders were probably carried thence across the Canadian extension of the Great Plains to the Rocky mountains.

Notes on the glacial geology of the Northeast Territories. By A. P. Low. A large region reaching from Hudson bay southeastward to lakes Nistassini and St. John was described in this paper. The interior of the country east of Hudson bay is mostly 1,500 to 2,000 feet above the sea, being a moderately hilly Archæan plateau, more or less covered with drift and commonly sprinkled with innumerable boulders. All the drift and courses of striation are explainable by the action of land-ice, which flowed outward to the west, south, and east from the watershed that divides the streams tributary respectively to Hudson bay and the Atlantic. The material of the drift is mainly of local origin, but some boulders are known to have been transported 200 miles.

A chain of islands extending from south to north in the east part of James bay is a terminal moraine. These islands are unstratified drift, rising to maximum hights of 150 to 200 feet. They were submerged for some time after their accumulation, for fossil marine shells are found in stratified beds overlying the till along the rivers flowing into the east side of Hudson and James bays to a distance of 40 miles inland, and the continuation of these deposits rises to an altitude of 670 feet. The ice-sheet here was probably thicker, and the Champlain submergence greater, than on the Labrador coast.

The hight of the Bay of Fundy coast in the Glacial Period relative to sea level, as evidenced by marine fossils in the boulder clay at Saint John, New Brunswick. By ROBERT CHALMERS. Close west of the harbor of St. John, N. B., the boulder clay or till encloses layers of stratified clay which hold marine shells. The till rises 40 to 60 feet above the sea and forms a tract about a half mile wide, overlapped on its borders by Leda clay and Saxicava sand. On the adjacent and underlying rock surface intersecting glacial striæ bear S. to S. 65° E., referred to the astronomic meridian. Directly north of this place are the rock hills known as Carleton hights, on which the striation bears S. 2° E. and S. 16° W. The materials forming the boulder clay came from rock outcrops on the north. Boulders are plentiful up to 8 or 10 feet in diameter. The upper part of the till is less compact than the lower, and landslips are frequent. Several sections of the till were described in detail, showing that it encloses thin layers of clay and sand with many shells of *Yoldia* (*Leda*)

arctica, and a few of *Saxicava arctica* and five or six other species. At the bay of Chaleurs and in other parts of New Brunswick fossiliferous marine beds resting on the till show that this region was depressed 175 to 220 feet during the Champlain epoch or time of departure of the ice-sheet. The St. John sections indicate several slight oscillations of the ice-front, as if it repeatedly retreated to the Carleton hills and re-advanced from them a short distance into the sea. The deposition of the Ledaclay ensued immediately after the recession of the ice.

Mr. UPHAM said, in discussion of this paper, that the occurrence of *Yoldia arctica* as the only plentiful species in the intercalated clay layers of the St. John sections implies that the front of the ice-sheet was near. This species is now found living only in the Arctic ocean and thrives most, according to the observations of Baron de Geer in Spitzbergen, near the mouths of streams discharged from glaciers and muddy with the fine silt of their erosion.

The abandoned strands of Lake Warren. By ANDREW C. LAWSON. As the author was not present, and had not forwarded this paper, it can be reported only by the following abstract sent by Dr. Lawson for the preliminary announcements of this meeting.

The strands of lake Warren, on the north side of lake Superior, up to an elevation of 1,200 feet above sea level, are postglacial. It was not an ice-dammed lake. There was an outlet northward corresponding to one of its higher stages. A postglacial depression of central Canada whereby the James bay slope was covered with marine sediments to a present altitude of 450 feet above tide and only 150 miles distant from lake Superior is correlated with the maximum fullness of lake Warren, and the subsequent uplift is correlated with its subsidence. The strand lines show no evidence of deformation. In the absence of ice dams and of a gorge of permanent drainage, the level of lake Warren could only have been lowered by epeirogenic depression along its southeastern margin, that is, in the region south of lakes Huron and Michigan, which depression is thus coeval with the postglacial uplift of central Canada. High terraces and beaches are known to extend along the north side of lake Huron from Sault St. Marie eastward, and they are reported on the high lands of the peninsula of Ontario; so that lake Warren must have been the greatest of the known late Qua-

ternary lakes. Its area is roughly estimated at 150,000 square miles.*

The Pleistocene history of northeastern Iowa. By W J McGee. This paper was a partial résumé of the author's memoir of this title in the Eleventh Annual Report of the U. S. Geological Survey, now in press. Two incursions of ice from the north have each spread a drift sheet upon this district, and in each case only little of the drift can be ascribed to a local origin. Probably 95 per cent. of both the earlier and later till and of the associated stratified deposits came from areas north of Iowa. Boulders of small size, comprising many of hornblende schist characterize the lower and older till, while the upper till has many large boulders of granitoid and gneissic rocks, usually occurring of all sizes up to 15 feet in diameter. Often much larger boulders are found, and one was mentioned having a diameter of 47 feet.

A very remarkable feature of the early glaciation of this district is the absence of glacial striæ, except in one isolated locality, on the bed rocks of a drift-covered country about 16,000 square miles in area. Not all of the preglacial residuary clay was removed, and no glacial erosion of the underlying rocks took place. Between the first and second ice incursions forests grew on this area and their remains form a forest bed of abundant logs and branches, with occasional peat accumulations, encountered by nearly every well of whole townships and traceable over several counties, lying between the lower and the upper till.

The eastern part of the district is covered with loess, and the western border of the loess has a descent like a terrace 10 to 20 feet or more, to the surface of the sheet of till which stretches thence westward upon the tract that was covered by the Minnesota and Iowa lobe of the ice-sheet while the loess was being deposited. Upon the till area loess occurs here and there forming ridges much higher than the surrounding land. These ridges named *paha*, trend in parallelism with the movement of the ice-

*A different view, which regards lake Warren as a glacial lake, held by the barrier of the retreating ice-sheet on its northeast side and attaining at its maximum stage probably only about half as great area as supposed by Dr. Lawson, is stated by G. K. Gilbert in "History of the Niagara River," Sixth Annual Report of the Commissioners of the State Reservation at Niagara, for 1889, pp 61-84, with three maps (also in the Smithsonian Report for 1890), and by Warren Upham in Bulletin of the Geological Society of America, vol. II, pp. 258-265, and vol. III, pp. 484-487.

sheet, and were deposited, like the gravel and sand eskers of other regions, in ice-walled channels of glacial rivers during the departure of the ice.

In the ensuing discussion, Prof. SALISBURY spoke of the exemption of the residuary clay and later of the forest bed from erosion by the ice invasions as phenomena of the marginal portions of the areas covered by the ice-sheets, while their inner and central portions were deeply eroded.

Prof. C. R. VAN HISE referred to the large size of the boulders in the later drift, which would suggest their probable derivation from a previously unglaciated region.

Mr. UPHAM remarked that the preservation of the preglacial soil and of the forest bed shows that the ice in both its incursions rolled onto this district, with little or no sliding and eroding action of its basal portion, bringing its drift enclosed within the ice instead of pushing or dragging the drift beneath it which would have been attended with much erosion of the bed rocks at the first and of the forest bed at the later incursion.

In the northwest part of Iowa, on the west side of this ice lobe, the Altamont or outermost moraine divides an area of till at the east from an area of loess 20 to 50 or even 100 feet higher at the west, showing the same relationship of the loess deposition to the contemporaneously ice-covered country as is found by Mr. McGee in northeastern Iowa. Not only the paha, or loess ridges, and eskers, but also drumlins, in their parallelism of trends with the ice movement, afford as reliable evidence of the direction of that motion as glacial striæ.

Dr. BELL stated that the hornblendic rocks of the Iowa lower till are abundantly developed northeast of lake Superior, while granites and gneiss predominate farther west.

Mr. McGEE, in closing the discussion of this paper, said that both the older and the newer drift of this district were probably transported in the same manner, whether subglacially or englacially. The consideration mentioned by Prof. Van Hise may be indicative of a very long interglacial epoch between the two ice invasions, sufficient for deep stream erosion, the isolation of cliffs and pinnacles of rock by weathering, and the production of boulders by disintegration of the bed rocks on the area of the earlier glaciation.

[TO BE CONTINUED.]

MAN AND THE GLACIAL PERIOD.

ANTIQUITY ON MAN IN EASTERN NORTH AMERICA.

By N. S. SHALER, Cambridge, Mass.

Some years ago after reading the most of the literature concerning prehistoric man in northern Europe, seeing the collections of the remains which had been gathered and examining some of the most indicative localities, I undertook certain deliberate inquiries to see what evidence of a similar nature could be found in this country. The first point I endeavored to examine lay in a field which otherwise interested me, that occupied by our caverns of the Ohio valley. Noting the fact that primitive man had extensively resorted to the caverns of the old world and had left there extensive accumulations of bones, his own and those of species on which he fed, with many other evidences of his presence, I expected to find similar deposits in our caves and rocks. A good deal of fruitless work led me to the conviction that cave dwellers never existed in the Appalachian district in the way they did in northern Europe.

In 1869 I made extensive excavations at Big Bone Lick in Kentucky, partly with the hope of finding human remains mingled with the abundant bones of extinct mammalia which occur in the deposits of mud at that point. Here again I gathered only negative evidences which went to show that primitive man never hunted the elephant, the mastodon, the Ovibos and other large animals which frequented this region about the time of the glacial period, probably when the ice lay over the region north of the Ohio. As this field would have been an excellent hunting ground for early man, as it was for their successors, the red Indians, and the frontiersmen, it seemed to me strange that I could not find a single trace of man below the level occupied by the living bison which evidently comes to this district in modern days. In this superficial layer made up mainly of bison bones, I found a number of arrow or spear heads. It also seemed to me important to trace the remains of the "mound builders" or early American Indians backward or downward to see if they graduated into those left by yet earlier varieties of man; with this idea in mind

I searched the banks of the Ohio and its tributaries for a distance of a hundred miles or more to see if the sections of its alluvium might show human or art remains of another kind than those derived from the known indigenes of this country. This work also proved substantially fruitless. Traces of savage man appeared at many points but they were all superficial: in the deeper parts of the sections I found nothing which could fairly create a suspicion that a really ancient member of the species had dwelt in this valley. Whenever I could establish anything like time ratios they seemed to show that man had not been at work in this part of the country for more than one or two thousand years. I attach little importance to these efforts I made to show the antiquity of these remains but the result of many such endeavors was to incline me to the view that the oldest of them did not, much, if at all, antedate the Christian era.

I have made little mention in print of my efforts to trace the existence of man in the region east of the Mississippi, partly for the reason that the evidence gained was purely negative and as such was of no great value; it seemed likely to be overthrown by subsequent inquiry. The only positive conclusion which I attained was to the effect that man had never taken to our caves or hunted our larger herbivora in the way he did in Europe, and if he occupied this part of the continent in the time when he was settled in the old world his habits were peculiar.

After these resultless efforts to get upon the trail of a primitive man in the eastern part of the Mississippi valley and at other parts in the southern Appalachians. I undertook in a more general way to search for such evidence in the New England district. Here too I failed to ascertain anything which could be reckoned as proof that man had been on the ground for two thousand years: in fact I have seen nothing which raised a presumption of his presence for half that time in the region north of New York. There is no clear evidence, however, as to the length of his sojourn in this district which is known to me.

It is perhaps well to say that at every stage of my enquiries both in New England and in the Ohio valley I have always found accommodating persons who were ready to supply me with just such evidence as they knew I desired to obtain. I remember a clever person near Cumberland gap who found ancient pipes "galore" in most improbable places; they were excellent antiques except as to

the tubes which when broken showed a singular irregularity in the penetration of the decay. I have had an excellent medallion of a European face tendered me with ample affidavits to prove that it was taken from compact upper Silurian beds in southern Kentucky, and in a more eastern locality a kindly farmer tried to sell me a swamp in which he was certain that I would find mammoth and other remains: he seemed, indeed, prepared to guarantee the importance of the prospective discoveries. By no means all of these helpful people seemed to be actuated by a desire for gain; many of them were clearly moved by a sincere wish to help a fellow to secure some pleasure in his way of life, and incidentally to see whether he was well informed as to the nature of *living* man. These negative and positive bits of evidence tended to make me rather critical of all the discoveries which I have seen or heard of which appear at first sight to show that man was in the region east of the Mississippi antedates the close of the last glacial epoch. I do not think, however, that I have been more of a skeptic than it is wholesome to be in such enquiries where above all else it is necessary to maintain a state of doubt, until the facts array themselves in a clear manner. While in this state of mind I saw the Trenton gravels where Dr. C. C. Abbott has made his important researches.

During my examination of Dr. Abbott's localities, which was very hurried, I saw only enough to convince me that the Trenton beds contained an abundance of chipped flints which have much the aspect of those which have been rudely shaped by human agency. At the same time I felt how difficult it was to account for their presence in the deposits if we supposed them to be the work of man. It was hardly reasonable to imagine that they were dropped into the water at the time when the beds were forming and to suppose that they were on the surface of the country whence the glacial waste came before the advent of the ice called for a yet more trying feat of the imagination. It was not difficult to find in New England deposits in history corresponding to the Trenton gravels and to these graded by Dr. Abbott's valuable discoveries and to these I addressed myself as opportunities were presented. I found readily enough that the sand plains of southern Rhode Island and southeastern Massachsetts deposits found on the seawardside of the moraines of the last ice epoch to which I have given the name of "frontal aprons" here and there contained chipped pebbles which to

my eye at least resembled those from Trenton, though none of them are so artificial in appearance as the specimens from that locality. Finally in the washed gravels of Nantucket I came upon a field where chipped stones were numerous and they seemed to me essentially like those from New Jersey. There were differences in the artificial looking bits from the two districts but these variations could, it appears to me, be accounted for by the unlikeness of the rocks whence the materials come.

Approaching the problem with some care I at first made a collection of the artificial looking stones which I found on Nantucket, endeavoring to ascertain the range in size and in the departure from perfectly normal pebbles. The results of this inquiry are set forth in Bulletin 53, of the U. S. Geol. Survey; briefly stated they are as follows: The apparently washed bits of this section vary in size from those less than half an inch in diameter to those weighing many pounds, and a foot or more in length. The variation in the measure of departure from the form of the ordinary pebbles is great; some of the fragments showed only a trace of fracturing on the edges and would not arouse any suspicion of artifice, others were so shaped that it is difficult to resist the conclusion that they have been deliberately shaped by man.

It became evident to me that if one searched these deposits of washed drift with the eye prepared to find implements, an unconscious choice was made of those having forms which would place them in this category; if, on the other hand, every chipped stone was taken the variety thus gathered was so great that it soon became at once embarrassing and instructive. It was made plain that somewhere near one per cent. of the flatter pebbles in certain parts of the deposit were thus chipped. The specimens were not exactly similar to those which I found in place at Trenton, but the difference was apparently due to diversity in the nature of the materials of which these fragments were composed. The evidence seemed to me irreconcilable with the supposition that these fractured stones were due to the work of man. They were too numerous and too varied in form, many of them could not have been chosen by the most primitive man with the intention of adapting the original form to any use. The only reasonable explanation seemed to be that which I offered in the above mentioned report, Bulletin No. 53, U. S. Geol. Survey. This is in effect as follows: When pebbles of any rock which contains

numerous undeveloped joints for a time lie in a position where they may be affected by decay the incipient fracture planes are thereafter easily opened by a relatively slight strain. Such a stress applied to the pebbles which now lie in our modified drift will often lead to the chipping of the stones. There is much evidence going to show frequent advances and recessions of the glacier during the last ice period: each of the pauses of the ongoing would be likely to give a chance for the process of decay to take effect. In the next advance of the ice one can readily believe that the movement developed the incipient fractures and polished the new made facets by the friction brought about in the moving mass of pebbles and sand.

I do not intend to say that all the artificial looking stones which have been found in our earlier drift deposits have been formed in a purely natural way, yet I am prepared to affirm that at least one enquirer who has tried to approach the matter in a dispassionate manner has found it necessary to guard himself in a careful manner from self deception as well as against the devices of others. It is clear that there are perfectly natural processes by which pebbles may be chipped in such a manner that now and then one of them may have a very artificial aspect. Finding unquestionable stone implements on the surface or at shallow depths, within the culture layer, it is natural to suppose that the lower lying chipped pebbles are ruder specimens of the same general nature. It is clear that just here we have a pitfall most dangerous for the unwary.

Older Drift in the Delaware Valley.

A. A. Wright, Oberlin, Ohio

So large a question as the unity or duality of the glacial epoch must necessarily rest upon a great variety of considerations. The only point to which reference will here be made is the question of the existence of a distinctly older drift in the Delaware valley, a region which I have examined with some care, and concerning which I will offer only the briefest summary statements.

It is stated in the geological report of New Jersey for 1891 that glacial deposits exist far south of the "terminal moraine" of the "second" glacial epoch, which crosses the Delaware river at Belvidere that these deposits cannot be considered as the attenuated

border of the later drift, but that they constitute one of the clearest proofs of an earlier glacial epoch.

1. The farther south these deposits are detected, the greater is the likelihood that they were independent of the later ice-sheet. Everything south of the moraine is treated as belonging to one category. A series of deposits is enumerated, beginning with Oxford Furnace and Little York, N. J., three miles south of the moraine, which all will concede are true land-ice deposits, and continuing on, without break, to "glacially striated boulders" at Monmouth Junction, N. J., thirty miles south of the moraine, "a subdued terminal moraine" eastward from Trenton, forty miles, "drift closely resembling till," at Falsington, just west of Trenton, and "drift" at Bridgeport, opposite Norristown, Pa., fifty miles south of the moraine, "the southernmost point at which glacially striated material has been seen."

Since it was pointed out* thatthese southernmost deposits are all within 100 feet above tide and have doubtless been transported by water and floating ice from the glaciated area, the author quoted has, as I understand, relinquished any claim that he may seem to have made, that an ice-sheet ever.extended further south than High Bridge and Pattenburg, N. J., about thirteen miles south of the moraine. This simplifies the problem, and greatly reduces the area which needs discussion.

2. The claim is still maintained that the glacial deposits south of the moraine exhibit such superior oxidation as to prove their vastly greater age. This is a more difficult question to decide. The claim should rest upon an extensive series of comparisons, and it should be shown (1) that the oxidation took place *in situ*, and (2) that it was post-glacial and not pre-glacial. The deposit at High Bridge, N. J., upon which stress is laid, certainly exhibits a high degree of oxidation and ferrugination, but it must be clearly differentiated from the deposits nearer the moraine, (*a*) in that it contains little or no material that has been brought from as far north as Kittatinny mountain, (*b*) in that it rests in a cradle of decomposing, ferro-magnesian, Archæan gneiss, into which its finer elements almost seem to graduate at the eastern end of the cut, thus suggesting that its material is mostly local and its oxidation pre-glacial.

3. The general composition of the deposits between the mo-

*AMERICAN GEOLOGIST, X, 207. Am. Jour. Sci., XLIV, 351.

raine and the southern border of the glaciated area is essentially the same as that of the moraine itself, and of the deposits north of the moraine. The bowlders are mixtures (*a*) of similar types of granitoid rocks from the far north, (*b*) of easily recognizable upper Silurian rocks from a moderate distance north, (*c*) of local types of gneiss, lower Silurian limestone, flint, vitreous quartz and slate. In many places there are such abundant accumulations of bowlders and till that the line of the moraine could well be brought farther south than it is plotted, without doing violence to the facts. The case in New Jersey seems similar to what is known in Ohio and elsewhere, viz.: that the moraine does not mark the southernmost extension of the ice-sheet, but only the first halting place in its northward retreat. A clearer differentiation of the earlier from the later drift is needed before we can be sure of its duplex character.

Supposed Glacial Man in Southwestern Ohio.

By Frank Leverett, Chicago, Ill.

The vast majority of so-called palæoliths* in this country are found on the surface or in talus, but few being even claimed by their discoverers to have been imbedded in the undisturbed deposits, either of glacial or of post-glacial age. The great preponderance of such stones on the surface naturally leads to skepticism as to the authenticity of the alleged finds in undisturbed glacial deposits. The interpretation of the age and method of imbedding of those reported to be in undisturbed deposits should, therefore, be supported by an array of evidence such as will leave no room for doubt as to its correctness. In few, if any, cases has a find been subjected to such a critical examination as would develop evidence of a conclusive nature. In the case of the finds in southwestern Ohio, where I am personally acquainted with the character of the deposits the conditions are as follows:

The Madisonville chipped stone was discovered by Dr. Metz in

*Mr. W. H. Holmes has demonstrated that a series of chippings similar to the so-called palæoliths are made in great numbers in the manufacture of modern neolithic implements. The so-called palæoliths, like the rejects among neoliths, show no signs of use. The presumption is that all rudely chipped stones that have been found are neolithic rejects, and strong evidence to the contrary is required in every individual case where palæoliths are claimed.

the excavation of a cistern at his residence. It was found about eight feet from the surface at the top of a gravel bed. The gravel is overlain by a reddish clay. This reddish clay occupies a basin of perhaps a square mile in extent, bordered on the north and east by an elevated upland, on the west by a nearly plane lowland tract underlain by bowlder clay and standing 20 to 40 feet above the basin, and on the south by a line of dunes or low sandy ridges fringing the bluff of the Little Miami river. If we examine the bordering districts we find a surface capping of pale silt 3 to 5 feet thick known locally as white clay. This white clay (on the uplands at least) is apparently of the same age as the main loess deposit of the Mississippi basin and is decidedly older than a late ice invasion whose outer moraine is found a few miles north of Madisonville. Perhaps the Madisonville red clay is of the same age as the white clay but of this we cannot as yet be certain for the situation is such, being in a lowland tract near the Little Miami river, that it might have received deposits at the flood stages of that stream down to a period as late as the late ice-invasion above referred to, and being in a basin it might have received deposits by the wash from the neighboring uplands even in postglacial time. It is, therefore, by no means easy, and in the present stage of investigation is not possible, to fix the exact age of the deposit. Even the indefinite chronological term "glacial terrace epoch" applied to it by Prof. Wright is not sweeping enough to cover all the possible range in time of deposition.

If we turn to the question of method of deposition we shall find ourselves even more at sea than in the question of the age of the deposits. The chipped stone was lying so near the surface that there are several ways in which it might have been intruded through natural agencies at almost any time since the red clay was deposited. Chief among these agencies are the following:

1st. By cracking and opening of the clay in seasons of unusual drouth. Cracks eight feet in depth are not at all rare in such deposits. Where a clay is underlain by gravel the conditions are especially favorable for their formation. 2nd. By roots of trees. In deposits of this kind the water level is liable to become very low in seasons of drouth. This being the case such trees as occupy this region, especially the white oak, would

send down tap roots to a much greater depth than eight feet. If now we take into account the number of generations of trees that have occupied this ground* it would seem probable that scarcely a square foot remains which has not at some time been occupied by large tap roots. When a root decays the surrounding earth settles into the cavity and if this process be repeated several times the amount of intrusion which a chipped stone might undergo is considerable. 3rd. By burrowing animals. These animals might begin their passage through a hollow, partially decayed root and thus help on an intrusion which the decay of the root had initiated.

It should be remarked that the above methods of intrusion may be sufficient to account for the occasional burial of a chipped stone but could not account for the occurrence, at this depth, of a stratum or well defined horizon characterized by a vast number of such stones. In the case under discussion, however, only the one stone has been found. It therefore remains a question whether it was dropped before the clay was deposited or has been buried subsequently.

The Loveland chipped stone was found by Dr. Metz in the valley gravels of a Little Miami terrace. These terraces occur now only as occasional remnants in the recesses of the valley so that continuous tracing cannot be made, but there appears no reason to doubt that the terrace at Loveland is the deposit of a glacial stream having the age of the outer moraine of the Miami and Scioto glacial lobes. This being the case it is referable to a distinct stage in the glacial epoch whose relationships to the glacial epoch as a whole are under investigation by the U. S. Geological Survey at the present time.

The bed at Loveland from which Dr. Metz extracted the chipped stone was exposed in a railway gravel pit and is 20 to 25 feet below the surface. It consists of loose gravel carrying considerable sand, it is nowhere firmly cemented and as a rule is entirely free from cement. The large admixture of sand might render it difficult to determine whether or not certain portions of it are undisturbed and even more difficult to determine whether a chipped stone or, for that matter, any particular stone had been

*It is estimated by Prof. Chamberlin, to whom I am indebted for many useful hints in the study of such questions, that in the time since the last ice invasion there would probably have been at least fifty generations of trees on this ground.

introduced into it by dropping from above, or by any other means. Upon my examination of these deposits in 1891 I expressed the following opinion, which, in the light of further reflection and wider acquaintance, has become a strong conviction: "When a question so important as that of the date of the appearance of man may depend upon the correct determination of the original position of a stone in such loose and poorly assorted gravel it is well to withhold judgment until every line of evidence has been thoroughly worked out. As the evidence now stands it is, in my opinion, not conclusively proven that man inhabited this portion of the Ohio valley during the glacial period."

Man and the Glacial Period.

Warren Upham, Somerville, Mass.

The extraordinary interest aroused by Prof. Wright's new book, "Man and the Glacial Period," seems to me attributable to the present transitional state of glacial geology, which, both in America and in Europe, especially in the United States and England, is passing from old to new interpretations of the great body of observations faithfully noted during many years. Whether the workers have seen the significance of their observations dimly and erringly or with clearness and sound judgment, in either case we owe much to their efforts as pioneers. If any investigators now see farther or better than their fellow-workers or than those of other countries or former years, it is largely due to the vantage ground given by the previous literature of the Ice age. Therefore every amateur worker who comes into this field and devotes his spare time to glacial explorations and studies, as Prof. Wright has done during the past fifteen years of our acquaintance, deserves the hearty welcome of all fellow-glacialists.

Prof. Wright is adversely criticised chiefly for his beliefs, first, in the unity or continuousness of the Ice age on this continent, and, second, in the contemporaneous existence of men occupying the entire width of the United States along the southern boundary of the ice-sheet. Opposed to the first of these opinions is the belief of his critics, that the glacial period here comprised two distinct epochs of glaciation, divided by a long interglacial epoch. It is claimed that the evidence for two glacial epochs is

most conclusively exhibited along the marginal portions of the drift; but this belt has been specially examined by Prof. Wright from the Atlantic to the Mississippi, and in Nebraska and South and North Dakota, from which he thinks that the best explanation is by a single glacial epoch, with moderate retreats and re-advances of the ice. In the light of Russell's observations of the Malaspina glacier or ice-sheet, which show that the forest beds of Illinois, Iowa, and adjoining states, may be readily explained by oscillations of the ice-border, the doctrine of continuous glaciation seems to me more probable than that of duality. It is helpful to have both views under consideration, since thereby more careful attention is given to the examination of the drift and to the study for a consistent and complete explanation of the Ice age and of the diverse ways in which the various deposits of glacial and modified drift were produced.

Some of Prof. Wright's reviewers think that there is so strong a presumption against the presence of man in America during the Ice age, that all the stone implements and flakes of their manufacture discovered in deposits of Glacial age by Abbott, Putnam, Shaler, Metz, Mills, Miss Babbitt, Tyrrell, McGee, Whitney, King, and others, should be rejected, as belonging instead to post-glacial times, because of this assumed improbability that men could have reached this continent before the end of the Glacial period. This prejudice seems to have no sufficient foundation. Before the beginning of written or traditional history, the three great races of mankind had become apparently as distinct from each other as they are to-day, and this historic period extends back nearly or quite to the time when the North American ice-sheet finally melted away. To me it seems far more probable that the native American peoples, now generally considered a division of the Mongolian race, had migrated to our continent from northeastern Asia during the early Quaternary time of general uplift of northern regions which preceded the Ice age, as shown by their fjords and submarine valleys. Then land probably extended across the present areas of Bering sea and strait; but during the Postglacial epoch, according to Dall, Bering strait has been somewhat wider and deeper than now, and the neighboring coasts have undergone recent elevation. The many divergent branches of the American peoples, and their remarkable progress toward civilization in Mexico, Central America and Peru, before

the discovery by Columbus, indicate for this division of mankind probably almost as great antiquity as in the eastern hemisphere, where many lines of evidence point to the origin and dispersion of men at a time far longer ago than the 6,000 to 10,000 years, which measure the Postglacial epoch.

Somerville, Mass., Feb. 3, 1893.

PREGLACIAL MAN NOT IMPROBABLE.

By E. W. CLAYPOLE, Akron, O.

The nature and date of the Ice-Age are important elements in the problem of the antiquity of man, because as we trace him back into the past, we seem almost to lose the trail when we touch the edge of the ice. Thus these questions are raised, "Did man live during the later stage of the glacial era, or was he even in existence, as man, before this last stage began?" So far as Europe is concerned, the former of these questions must be affirmatively answered, and not a little evidence has been accumulated toward giving a similar reply to the other. But in regard to North America, the question at present stands in a different position. A certain amount of evidence has been collected, satisfactory to many, but not to all archæologists, in favor of man's presence here immediately after the culmination of the glacial era. But we have as yet absolutely no reason for thinking that North America was a human abode before the last oncoming of the ice-sheet. The discrepancy is puzzling. The antiquity of the human race, judging from the facts thus far attained, must apparently be greater in Europe than in America. That the old world should be the evolutionary home of the race is in harmony with the facts of biology. *There* are to be found, all the four anthropoid apes, man's nearest animal relatives. And not only so, but the monkeys and baboons, more distant still, are entirely Eurasian and African. Only the comparatively distant cebids or spider-monkeys, etc., are natives of the western world. Their anatomical structure is so different from man's, that comparison is out of the question.

And yet when we consider the wonderful manner in which man, even savage man, has wormed himself into the most inaccessible places, such as Easter and the other islets of the Pacific, it is

difficult to understand why he failed to reach and occupy so large an area as America, which seems to be as accessible then as now, or, at some periods, even more so. Negative evidence is proverbially untrustworthy in geology, and we may yet come upon the trail of glacial man on this continent.

So long as the astronomical theory of glacial climate prevailed, biologists hesitated to accept a doctrine which required them to assign a specific life to man of 80,000 years if only post-glacial, and of 150,000 if inter-glacial. So long a time, though possible, was against probability. But now that more moderate figures are being adopted, their reluctance to believe in post-glacial and glacial man is giving way, and they are more willing to allow the evidence.

It is, however, still impossible to assign a date to glacial time. If the era was interrupted by a long inter-glacial spell of mild climate, when the ice entirely disappeared, higher figures are necessary than if the era was unbroken. On this point, the most energetic controversy now prevails. Granting the former and the inter-glacial date of man, or some anthropoid deserving that name, his age must be much greater than on the latter view, and yet need not be so great as to alarm the biologist. The enormous figures given by some are probably quite transcendental. Suspense of judgment and patience, are the proper states of mind in the present condition of the question. Positive statements, such as some that have recently appeared, are entirely premature and unwarranted.

Yet one word more. It is not likely that the evolution of man was sudden. If an anthropoid or several such intervened between him and the pithecoid branch from which he and his simian relatives have sprung, time must be allowed for the process of development. If then all the traces of worked or used stones thus far found are human indications, we must allow to man's semi-human ancestors, an earlier era in which they more or less slowly emerged from the brute.

When all these considerations are taken into account, there seem to be no valid objections to the existence of inter-glacial or of glacial man, but on the other hand, strong grounds for anticipating that his remains or traces will be found more abundantly and possibly of a date older than any yet met with.

When the testimony of history is added, we may go one

step farther. The story of Egypt, as now understood, carries us back at least forty centuries before the Christian epoch. At that time, Egypt was no nation of half-civilized men, still less, of barbarians, but she possessed a stable government, a wide influence, and above all, the art of writing in a rudimentary form. The slow progress that was made in early times, compels us to believe, that such a condition argues not a few centuries of preceding development from savagery, either in the valley of the Nile or elsewhere. When the necessary addition is made to Egyptian chronology for this reason, we are almost driven to the admission that that empire may have been in existence, though infantine, while the glacial sheet was yet lingering over North America, if not over northern Europe. Neolithic man may yet be traced back to the valley of the Nile, and the dark continent may prove to have been the mother and the nurse of civilization and the arts.

The differentiation of the varieties of the human family at so early a date, as shown by the monuments, proves that in times so distant the race was ethnically nearly as it is now. The ante-Egyptian era must therefore on this ground have been long. Without taking an extreme view, time must have been one of the potent factors in the differentiation and distribution of man.

Accepting then the comparative recency of the ice-age, and the antiquity of man chronologically, it is difficult to find good antecedent ground for rejecting evidence in favor of glacial or inter-glacial or even pre-glacial man. All such evidence, must of course, be most carefully sifted, as it has been in Europe, but we cannot see any reasonable ground for the excessive perturbation of spirit which some archæologists and geologists have shown over a brief summary of the facts, as already accepted by many. Only the devout believer in the special creation of man without any organic or genetic connection with his "poor relations," so-called, need be at all excited over the Tuscarawas flint and other "finds." Whether palæolithic or not, we will not enquire. This distinction has not yet crystallized here as in Europe and especially in England. Those who adopt the evolutionary belief in man's origin will see in this and other similar instances merely what was to be expected, and the only question to be solved will be—Did man in America advance from very early and rude conditions to those of historic times, or did he migrate at a later stage from

the old continent, and only pass the relatively higher portion of his development here? At present the answer inclines toward the latter view, but this may be reversed at any time by new discoveries. We must await the result.

PROFESSOR WRIGHT'S BOOK A SERVICE TO SCIENCE.

By N. H. WINCHELL, Minneapolis.

If Prof. Wright has made a mistake in the presentation of the case of palæolithic man, it is his misfortune rather than his fault. Not admitting that he has made any mistake we have still to admit that the evidence of palæolithic man in America has not been all first-class either in quality or in quantity, and that at about the same date as the appearance of his book Mr. Holmes and others were assiduously studying the question and revising much of the old data, subjecting them to such a scrutiny as the importance of the question demanded. Mr. Holmes seems to have demonstrated the inadequacy of much of the evidence that was relied on, but this was not known at the time Prof. Wright was writing, and he is not to blame for depending on such evidence as he had available. The book is designed to present the evidence as it stood, and I do not know that any one in his circumstances, writing at that time, would have come to any other conclusion. If that evidence finally shall be all rejected it will be a service to science that it was allowed its full value in such a summary; if it be sustained it will be a striking instance of Prof. Wright's sagacity and discrimination. Prof. Wright is a well known glacial geologist and has exercised the privilege which every American citizen has, of using published records, discussing them, and combining them to reach such conclusions as he may feel warranted to publish, and for that he should not be held to personal account.

A SINGLE GLACIAL EPOCH IN NEW ENGLAND.

C. H. HITCHCOCK, Hanover.

With the identification of terminal moraines of the great ice-sheet in New England it is possible for us east-iron geologists both to study phenomena analogous to those known from the west, and to observe their connection with marine deposits. So far as known it has seemed to me that the New England phenomena do

not call for more than one ice period, subdivided into epochs by successive terminal moraines. There are forest beds and clays between sheets of till, but nothing of much magnitude—nothing more than could accumulate in the time elapsing between the formation of the moraines. On the sea shore we have clearly, first, an early pre-glacial Quaternary deposit with numerous fossils, such as the quahog and oyster; second, the Champlain marine beds, both littoral and pelagic, of an arctic character, and hence, presumably glacial; and, third, sands and clays with modern shells and other organisms in them. Many of the so-called Champlain deposits belong to this later period. The possibility of a dual Ice-age has always been borne in mind in my glacial studies, but I have not yet seen any wide-spread phenomena demanding such an interpretation of nature.

What was the Origin of Post-Glacial Man?

Prof. Putnam regrets that, much as he would like to express his views on the subject of palæolithic man, his duties make it impossible at present. He says: "Nothing which I have yet read on the subject has shaken my faith, as these articles have only been partial treatments of the subject; while all admit that man must have been on the North American continent at least as early as the close of the Glacial period. I simply ask, Where did he come from at that time?"

Additional Evidence bearing upon the Glacial History of the Upper Ohio Valley.

By Prof. G. F. Wright, Oberlin.

Several of the most important questions relating to present discussions concerning the unity of the glacial period in North America have much light shed upon them by the gravel deposits of the upper Ohio valley. As is well known, these deposits are mainly found at two rather definite levels. The lower terraces rise directly from the river bed to a hight which rarely exceeds 120 feet; even this hight is attained only where the northern tributaries which come in from the glaciated region, were supplied, during the close of the glacial period, both with superabundant floods of water and with superabundant glacial *débris*.

The terrace upon which the better portion of Cincinnati is built represents one of these enlargements of the lower set of glacial terraces. Another appears at Portsmouth, at the mouth of the Scioto, and another just below Marietta, at the mouth of Muskingum. No other appears in going up the river, until reaching the vicinity of Big Beaver creek, which is the first stream of importance which comes into the Ohio from the glaciated region between Marietta and Pittsburgh. The bouldery terrace at the mouth of the Beaver is about 130 feet above low-water mark.

But the trough of the Ohio has been eroded to a considerable depth below its present bottom, and has been filled with gravel, in places at any rate, up to the hight of the terraces just mentioned. At Cincinnati the rock bottom is more than 100 feet below the present bottom. The Tuscarawas river and Beaver creek have likewise been filled up for more than 100 feet above their rock bottom.

The present channel of the Ohio river occupies a comparatively narrow trough or gorge worn through parallel strata of limestone and sandstone to an average depth, estimated from the rock bottom to the rock shell of the ancient base-level, of about 300 feet. The rocky shelf marking this ancient base-level is fairly distinct in the whole upper portion of the Ohio and of its tributaries. The narrow gorge or trough eroded in it is probably not less than 1,200 miles long, as the river runs, while the gorges of the tributaries would almost double the amount. Now the bordering rocky shelf of the ancient base-level is covered at various places with extensive water deposits containing considerable granitic material, both in the shape of gravel and small pebbles and occasionally of boulders of considerable size. That the water making this deposit was iceladen is evident from frequent angular fragments, from one to three feet in diameter, which are mingled with the finer stratified material. These upper terraces are therefore clearly of glacial age. For as there is no granitic material in place in the upper Ohio valley, it could only be derived from the *débris* brought by glacial ice into the valley from Canada or the Adirondacks.

The question raised by the facts here summarily stated is whether or not this vast erosion of the trough of the Ohio below the level of the upper gravel terraces was preglacial or intergla-

cial. Prof. Chamberlin is strongly of the opinion that it is interglacial, and that this immense erosion marks the separation in time between the first and the second glacial periods. Some idea of how great the lapse of time would be may be obtained by comparing the generally acknowledged postglacial gorges, like those below the falls of Niagara and the falls of St. Anthony, which are only a little over seven miles long, with this supposed interglacial gorge, which is deeper than the others mentioned, and from 150 to 200 times as long.

The theory which I, with many others, have maintained is, that this gorge of the Ohio is preglacial, having been worn with considerable rapidity during the continental uplift which culminated contemporaneously with the climax of the glacial period, when the general elevation was considerably more than now; that then, during the Champlain subsidence, which increased northward, the gorge was filled with water and to a considerable extent with glacial *débris*, when these deposits were made upon the rocky shelf of the old base-level. My theory of the glacial dam at Cincinnati was at first thought by the Pennsylvania geologists to give much assistance in simplifying the problem and in accounting for the facts, and while doubtless it was at first worked for rather more than it was worth, it is by no means clear that it has been entirely disproved or rendered entirely useless.

The most important crucial test which I have heretofore presented was that of Beech flats, in the northwestern part of Pike county, Ohio, at the head of the Ohio Brush creek. The facts respecting this with a map were detailed in my Bulletin (58) of the United States Geological Survey, pp. 92-96, and repeated in my volume on "The Ice Age in North America," pp. 332-335. These flats lie in front of the glacial boundary, where it passes over into the headwaters of the Ohio Brush creek. It is from 900 to 1,000 feet above tide, and from 400 to 500 feet above the Ohio river at the nearest point. It is evidently a deposit from glacial streams where they entered still water. Otherwise Ohio Brush creek would have been lined with glacial terraces throughout its extent, as all other streams similarly situated are. But there is no such distribution of gravel down the Ohio Brush creek, as ordinarily characterizes the streams which flow southward from the glaciated area. Evidently from some cause there was here a still water level which was maintained until the ice

had withdrawn a short distance into the watershed of Paint creek, which flows into the Scioto at Chillicothe, and which is strikingly marked by glacial terraces. The most likely explanation of this complicated series of facts is furnished by the Cincinnati dam.

The additional evidence which I now have to present is similar to that afforded at Beech flats, and was discovered last December while exploring the lower portion of the valley of Big Beaver creek, Pa., under the guidance of Mr. Richard R Hice. It will be remembered that two or three years ago Dr. P. Max Foshay and Mr. Hice made an important discovery of glacial furrows in the Beaver valley three or four miles south of the limit which Prof. Lewis and I had set to glacial action in that vicinity. These furrows were on the west side of the Beaver, near the southern line of Lawrence county, a little above the mouth of the Connoquenessing creek, which comes in from the east.

On reviewing this ground with Mr. Hice, we found a pretty well-marked terminal moraine on the promontory just above the junction of the Connoquenessing with the Beaver. Below this point, as well as above, the rock shelf of the old base-level spoken of was covered for some miles with overwash gravel, and, upon the western side especially, lay occasional boulders of large size, which had probably been distributed by water more or less choked with floating ice. The elevation of this rock terrace here above the river which occupies the narrow eroded gorge is about 160 feet, or 225 feet above low water mark in the Ohio at the mouth of the Beaver. The significant discovery made by us was that, as we followed this rock shelf down stream a few miles into Beaver county, suddenly the overwash gravel nearly disappeared at Stackman's run, in Big Beaver township, the ridge which we had been following ending abruptly at the face of the precipice, on the west side of the narrow trough of the river. From this point a mile or more down to Clark's run, which enters the Big Beaver at Homewood, there was but little superficial material on the rocky bench.

Clark's run comes in at right angles to Big Beaver, and has worn a deep gorge through the Homewood sandstone directly across the bench we were following. Though the stream is small, the gorge is 300 or 400 feet in width, and is worn down nearly to the depth of the Big Beaver. The significant facts meeting us here were that, while the south side of this gorge of Clark's

run consisted of bare rock and rocky *débris* which had fallen down from the face, on the north side the face of the rocks was entirely obscured by a sedimentary deposit which had evidently been brought in by a stream flowing over the rocky bench from the north which here met the gorge when it was full of still water. It is, in short, a regular delta deposit, where for a limited time the coarse material had settled in the deep water as it was brought over the precipice. Granitic material was frequent in this deposit; the stratification sloped downwards towards the axis of the valley; the depth of it exposed was fully 80 feet; how much more we could not tell.

To the south of Clark's run as far as Wallace run, a distance of little over a mile, the bench was bare of drift material.

I see no explanation of these phenomena, except that which assumes the preglacial erosion of the under part of the troughs of these streams, and that the streams consequent upon the melting of the glacier above were moving down the valleys when the lower depths of water were practically stagnant. This stagnation may have been produced by a greater northerly depression of the land than I have thought to be probable, or by the Cincinnati ice dam, which might well enough account for the facts here, or by a combination of the ice dam with a more moderate amount of change in the land level. It is true, however, that it would be possible to suppose that this deposit at Clark's run was made at the climax of the second glacial epoch: thus allowing the erosion to have been interglacial; but in that case the causes assumed would have to be supplied during this second glacial epoch.

Accumulating facts of this sort strengthen me in the conviction that the *inter*glacial erosion of the lower 300 feet of the troughs of the Ohio and its tributaries is far from being proved, and that the theory that the erosion was *pre*glacial may still be entertained by intelligent geologists.

The Cincinnati Ice Dam.

Joseph F. James, Washington.

While the presence of an ice dam at Cincinnati has been discredited of late, there are features in the physical geography of the vicinity of that city which make its presence more than probable. A few of those with which the writer is familiar from

long residence in the locality, have been referred to in detail in papers elsewhere. All that is attempted here is a brief resumé of some of the more important points.

East of the city lies the valley of the Little Miami river, the width of which is far greater than the volume of the stream at present justifies. The valley at the point where it enters the Ohio is some four or five miles wide, and is without rock any where extept on its borders. At Red Bank station, about five miles from the mouth, is a very heavy deposit of water-worn gravel, far above the present level of the river, forming, in fact, a second bottom or terrace. This terrace extends to Batavia Junction, where it is made up of fine silt, clay, conglomerate and till, rising 100 feet or so above the ordinary stage of water. About two miles further up the valley to the northeast, near Milford, is another, and an enormous bank of gravel, about 1½ miles long and a mile wide, and of unknown depth. The top of this is nearly level and abuts against the bank where the rock is exposed.

Extending northwest from Batavia Junction, and at present filled with drift, is a wide valley, reaching to Madisonville. some five or six miles. At this point a lake-like expansion occurs, and the valley turns westward, encountering at Ludlow Grove, on the line of Mill Creek valley another very extensive bank of gravel. Now it is impossible that the Milford bank was deposited by any stream only as large as the Little Miami now is ; and it is equally impossible that any existing stream could form the deposits at Batavia Junction, Red Bank and Ludlow Grove. The deposits are undoubtedly of glacial and of water origin. We know that the country to the northward was occupied by glaciers. Beds of till with abundance of striated pebbles indicate this, and the lower places were inevitably filled with ice. Once in the valleys mentioned the ice foot would extend to the Ohio river, would fill its bed, and would thus block its course.

A second valley, lying on the west of the city and now occupied by Mill creek, is also a pre-glacial channel, filled at its mouth with a mass of gravel and drift which gradually increases in thickness to the north. The Cincinnati terrace is also of pre-glacial origin, and probably represents the ancient bed of the Ohio when it flowed at a higher level than now. At Ludlow Grove the Mill creek valley and that from Batavia Junction and Madisonville unite, and together extend to Hamilton, some 20 miles north,

the drift gradually increasing until it is 200 feet and over in depth. Here, too, is an immense deposit of gravel, and at this point the Big Miami river enters, flowing in another wide valley. Together these united valleys turn southwest and after following a meandering course for some 20 or 25 miles, enter the present drainage of the Ohio near Valley Junction. In the course of this valley there are again enormous water deposits, and at its mouth is another phenomenally large gravel and till deposit. Down this valley another tongue of ice must have extended and blocked the Ohio channel again.

It is a peculiar fact that between the mouth of Mill creek and the Big Miami river there is not a stream of any length entering the Ohio river from either north or south. We find, however, opposite the mouth of Mill creek, on the Kentucky side, that while rock is exposed immediately on the river's edge, below it, and a short distance back, less than one-eighth of a mile, is a high, almost isolated hill, composed of drift material. Further down the drift is piled up against the lower part of the north side of the rocky bank, but it tails out to nothing before reaching the top, some 350 feet above low water. Down the river from this hill, again, is a great embayment, and here we find still another deposit of water-worn gravel, this time not in a valley occupied by any stream at present. It was possibly deposited from the Mill creek valley, down which a third ice tongue must have come, uniting with that from the Little Miami valley.

Opposite the main part of Cincinnati, on the Kentucky side, the Licking river enters the Ohio. Here we have another of the wide valleys so characteristic of the region, one out of all proportion to the size of the stream now occupying it, and bounded by rock banks on either side. This would allow the tongue of ice from the Little Miami valley to find egress to the south without having to surmount the tops of the hills. The water from the melting ice would probably find its way along the upper valley of the Licking, and, overtopping the low divide, enter the drainage area of the Kentucky river and so reach the Ohio below the dam. The main stream of the Ohio, meanwhile, was deflected from its course higher up, and may also have entered the drainage of the Kentucky river.

Now, the retirement of the ice up these valleys would account for several facts. (1) It would explain the great deposit of

gravel at Milford, in the Little Miami valley. (2) It would explain the Red Bank and the Ludlow Grove deposits in the Madisonville valley. (3) It would explain the deposit of till and gravel opposite and below Mill creek valley. (4) It would explain the deposit at the mouth of the Big Miami valley; and (5) it would, as the ice receded northward, account for the accumulation of drift near Hamilton. Of course, when the Ohio attempted to return to what was evidently its old channel, by way of Red Bank and Ludlow Grove on the one hand, and Mill creek on the other, it would find the way blocked; and it would then have to cut for itself a new course. This it has done past the mouth of Mill creek. Looking, therefore, at the facts as seen at and about Cincinnati, the theory of an ice-dam does not seem untenable. In fact, it is almost a necessity. It may not have performed all the work that has been credited to it, and its existence may have been long or short. This can possibly be measured by the extent of the deposits mentioned. All of these merit and require more extended study.

THE CAUSE OF AN ICE AGE.—*Ball.*

J. F. BLAKE, in *Annals of British Geology*, 1891, p. 142.

The name of the writer of this book is sufficient to secure great attention to what he says—but, when to follow him involves the imputation of a fundamental error to Herschel and of gross ignorance to all other writers on the subject, we must pause. If the words of Sir John Herschel had the meaning which the author assigns to them, they would lead to the conclusion that the author draws from them,—and arithmetically works out so that there can be no mistake,—that the only difference between summer and winter temperature is that due to the concentration of equal quantities of heat into unequal periods of time. But it would have this further result that in the hemisphere which has a long summer and a short winter the summer would actually be the colder. We cannot possibly believe that Herschel and his followers could not perceive this result. It is perfectly clear that the heat spoken of by Herschel is the "supply" from the sun, and is supposed throughout to be received on an equal area equally inclined to the sun's rays. The phenomena of summer and winter depend, of course, on something else altogether, namely, the obliquity of the surface

to the sun's rays. If θ_1, θ_2 be the local meridian obliquities, n_1, n_2, the number of days, h_1, h_2, the total "heat," in the above sense, received in summer and winter respectively in each hemisphere, then the meridian heat secured by that hemisphere on any one day may be roughly stated as proportional to

$$\int \frac{h_1 \cos. \theta_1}{n_1} d\theta \text{ in summer, and } \int \frac{h_2 \cos. \theta_2}{n_2} d\theta$$

in winter; and what Herschel says is not that $\int h_1 \cos. \theta_1 d\theta = \int h_2 \cos. \theta_2 d\theta$ which would correspond to the numbers 63 and 37 but that h_1 equals h_2.

But besides this the meridian heat integrated along the meridian, as is done by the author, will not give the total heat, which depends also on the length of the day at the various times and places. The total heat received at any latitude is completely worked out by Haughton (Trans. Roy. Irish Academy, Vol. XXVIII), and the integration of his expressions, which are discontinuous at the arctic circle, can alone give the total heat secured, a matter, after all, of little consequence, as it will include the tropics which do not enter the question. The numbers 63 and 37, therefore, have no significance whatever. The notion that the beds of a rock formation have any relation of any kind to glacial periods will seem absurd to every field geologist.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Annals of British Geology. PROF. J. F. BLAKE, F. G. S. Dulau & Co., London; $2.25, 8vo, pp. 404, six plates. This volume contains a record of the geological publications in Great Britain during 1891, with an appendix for 1890. It has been compiled by Prof. J. F. Blake, president of the Geologists' Association of London. More than once before the attempt has been made to conduct such a work, as, for example, by Mr. Whitaker, a few years ago, in "The Geological Record," but the great cost has prevented permanency. The value of such books is unquestionable and needs no words to enforce it to the student and the worker. The difficulty of making both ends meet is equally certain, if not to all, at least to those who have undertaken them. Unless subsidized in some way by learned societies it seems improbable, judging from the experience of the past and reasonable

forecast of the future, that better results, in a pecuniary sense, will be obtained

Of his present effort the author says: "The price of the first volume of the 'Annals of British Geology' was fixed at 5 shillings, in the hope that it might thereby reach a larger number than those who have usually subscribed for 'Records,' but this hope has, unfortunately, not been realized. The second volume, which is larger and is illustrated by six plates, is priced at 7s. 6d. to subscribers and 9s. net at the publishers'. It is found, however, that this is scarcely likely to cover the cost, and that the sale must be reckored on no larger a number than that of the supporters of the geological or zoological records. The former, aided by a grant from the British Association, and containing between 300 and 400 pages, was issued at the 'low' subscription price of 10s. 6d.; the latter, supported by the Zoological Society, is issued at 30s. for about 1,000 pages. It does not, therefore, seem probable that the present 'Annals,' supported only by its subscribers, can ever be issued without loss at a less subscription than 10s. and it would even then require a considerable increase in the number of its supporters. It is hoped that the third volume will be still further improved, suggestions toward which will be gladly received, and it will contain a minimum of 400 pages and six plates or their equivalent of figures."

We may express the hope that at the price above named sufficient support will be secured to enable the author to continue the work. Though principally of use to British geologists, yet others who take a wide view over their special departments of the science can scarcely afford to be without it.

The first part of the volume contains the titles and short abstracts of works and papers on general geology, occupying 52 pages. Then follows Structural Geology, 120 pp., including all the contributions on this topic. Palæontology, including Anthropology, fills 70 pages, Mineralogy 30, Petrology 45, and Economics 20 pages. Then follow 50 pages with summaries of papers and works on geology published in Great Britain and an appendix of 4 or 5 pages for 1890. A good index of authors renders the book more available for reference than it would otherwise have been.

The author does not confine himself to bare announcement of the subject of the papers and books, but gives these fully enough to enable the reader to determine if he need procure them for the purpose of investigation. His own criticisms and remarks are confined to foot-notes—an excellent device—as it avoids interrupting the summary and confusing the author and the summarist.

When we add that both summary and comment have been sent to the authors for revision, we show plainly that Prof. Blake has spared no pains to render his book fair, trustworthy and complete. We trust those of our readers who go beyond the locals in geology will procure it for future reference and consultation.

Geological survey of Missouri. Vol. II, *Report on iron ores*, 1892. From field work prosecuted during the years of 1891 and 1892, with 62 illustrations and one map; by FRANK L. NASON, assistant geologist, Jefferson City, 1892. Roy. Oct. 366 pp.

Vol. III. *Report on the mineral waters of Missouri*; by PAUL SCHWEITZER, embodying also the notes and results of analyses of A. E. WOODWARD; field and laboratory work conducted during the years 1890 to 1892, with 45 illustrations and one map, Jefferson City, 1892. Roy. Oct. pp. 256.

These two volumes certainly show commendable progress in the development of the economical geology of Missouri. Mr. Nason has arrived at important results in respect to the origin and distribution, as well as the age, of the rocks and the ore which they contain.

The ores of Missouri being either hematite or limonite, are confined practically, the former to the porphyry region, the Lower Carboniferous and the Ozark series, and the latter to the Ozark series.*

Very full details are given of the localities where these ores are known, and particularly of all points at which some working has been done. General discussions are presented of the specular iron ores of the porphyry region, of the red hematites, of the specular ores of the sandstone region, and of the limonites, also of the geology of the Ozark uplift.

The specular iron ores of the porphyry region are those of Iron mountain, Pilot knob, Cedar hill, Shepherd mountain and Clark's mountain. They are well known as the principal ore deposits of Missouri. Here the ore occurs, primarily in veins and in isolated grains which is a rare method of merchantable iron ore; but from these veins have been derived, through the decay and denundation of the porphyry, beds of conglomeritic debris which consists largely of blocks and boulders of hematite, and from these have been mined large quantities of the best hematite. The stratigraphic relations indicate that this disintegration took place sometimes in pre-Cambrian time, but has also gone on in more recent geologic ages; these boulders are in the Cambrian and in the residuary clays of the Pleistocene and present. The original veins are of all thicknesses, from mere films to forty and sixty feet. In places they form a perfect network in the solid porphyry. Iron deposits of like character also occur in the associated granites, but in general such have not yet proved sufficient to be of value. These hematite deposits in the veins of the porphyry are considered to be due to infiltration by percolating waters. The source of the iron is supposed to have been the ore disseminated through the decayed and chiefly removed porphyry which once covered the veins or which formed the surrounding country. This theory is ingeniously applied to Iron mountain and other prophyry knobs containing ore in veins. While Mr. Nason is disposed to regard the rock of these hills as probably of sedimentary origin, he

*For the significance of the term "Ozark Series" see AMERICAN GEOLOGIST, vol. VIII, p. 33, 1891.

unhesitatingly assigns that of Pilot knob to a sedimentary origin, and the ore found in it to cotemporary sedimentary action. But this requires that it be of later date than the Iron mountain rock and unconformable upon it, a supposition fully borne out by the coarsely fragmental character of the rock of Pilot knob, and by the widely different structural character of the ore. The chief obstacle which occurs to us, against the infiltration hypothesis, is the fact mentioned by Mr. Nason, that in the original vein ore are considerable crystals of apatite and occasionally of hornblende.

It will be noticed that Mr. Nason's examinations of Pilot knob do not lead to the same result as those of Prof. Haworth, but he finds unmistakable evidence, admitted by Prof. Haworth, that the rock there furnishing the ore, while largely of porphyry conglomerate, is of sedimentary structure. Prof. Winslow says in his letter of transmittal: "During the past summer a conference and joint excursion to this field was arranged for. The party consisted of Prof. C. R. Van Hise, Prof. Wm. B. Potter, Mr. Nason, Prof. Haworth and the writer. A result of this trip and the consequent discussion on the ground was the yielding, by Mr. Haworth, of his position with reference to the origin of the porphyry conglomerates, iron ores and other immediately associated beds occurring at the summit of Pilot knob and at a few other localities in the immediate vicinity. Mr. Haworth now concedes that the evidence favors the conclusion that these beds are of sedimentary origin rather than of igneous origin as previously advocated by him." (See AMERICAN GEOLOGIST, vol. i, pp 280 and 363, 1888, also vol. ix, p. 55.) Mr. Haworth's earlier determination was based on microscopic examinations of rock samples, after brief study in the field; Mr. Nason's on field studies solely, though he had Mr. Haworth's publications constantly in mind, and was compelled by them to give the subject more thoughtful and thorough attention. The result, as it appears now, is another striking instance of the pitfalls into which petrographical students are liable to lead the unwary geologist. It shows either the incompetency of their criteria or of their observations, and the superiority of field studies conducted by a competent geologist.

The red hematites of the Lower Carboniferous are quite unimportant, but they constitute original and distinct beds among the sedimentary strata.

The specular ores of the sandstone region, one of the strata of the "Ozark uplift," called Roubidoux sandstone by Mr. Nason, are fine-grained and compact, and apt to be of low grade by reason of large per-centages of silica. They are supposed to be due to concentration by percolating water from other and higher strata which have been removed subsequently by disintegration and erosion.

The limonites are principally confined to the Ozark district, but not entirely to the Ozark series. They affect the limestones, but also occur in cherty clay, the residuary product of the limestone. They take on all the pseudomorphous forms peculiar to limonite, and are found in

caves, pockets, crevices and sinks. They are of secondary origin. They are generally regarded with disfavor by furnacemen because of high percentages of silica and phosphorus.

Prof. Schweitzer's investigation of the mineral waters of Missouri was directed to ascertain their comparative composition and value, to furnish reliable data for the guidance of physicians and for the information of citizens, and to attract to the state any others who desired to improve and develop the various localities. The report embraces not only the prior results of Mr. A. E. Woodward, who at first had charge of the investigation, but also those of Prof. Schweitzer extended over many years as professor of chemistry at the State University. It gives an account of the nature and origin of mineral waters in general, and a classification—the classes being: 1. Muriatic waters, such as contain, as their main constituents, sodium chloride or common salt; 2. Alkaline waters, such as contain sodium or magnesium carbonate; 3. Sulphatic waters, such as contain one or more sulphates as their main constituents; 4. Chalybeate waters, such as contain as their most effcient constituent some ferrous carbonate, and 5. Sulphur waters, such as contain sulphides, sulphydrates, or sulphuric acid.

Chapter III elucidates the therapeutics of mineral waters, and enters into a discussion of the general uses of ordinary and of mineral waters, giving hints to physicians and to invalids. The volume contains a vast amount of special information relating to the various mineral springs and health resorts of the state, each important water having been analyzed; and comparisons are instituted with some European mineral waters of repute. A valuable feature of the report is a "bibliography of mineral waters" arranged chronologically, beginning prior to A. D. 1500.

The Metaspermæ of the Minnesota Valley: a list of the higher Seed-producing plants indigenous to the drainage-basin of the Minnesota river. By CONWAY MACMILLAN, State Botanist, Reports of the Geological and Natural History Survey of Minnesota, Botanical Series I, pp. XIII—826, Oct., with two maps, Minneapolis, December 29th, 1892; Harrison and Smith, State Printers.

The first 570 pp. of this work are largely occupied with a critical geographical and bibliographical list of metaspermic plants considered as indigenous to the drainage-basin of the Minnesota river. Of families, 106 are recognized, of genera, 407, and of species, 1,174. Following the list are chapters on the valley of the Minnesota, relationships of the metaspermic flora of the Minnesota valley and statistics of metaspermic plants of the Minnesota valley, together with bibliographical citations, summaries, tabulations and a very complete index to the list, covering nearly 60 pp. To the geologist the chapter on the relationships of the Metaspermæ is perhaps the most interesting. In this somewhat condensed account, a striking new view is advanced and very briefly argued, concerning the probable physiognomy of the

Cretaceous flora. In view of the existence of transitional areas between distinct plant-formations, it has been attempted to lay the ground-work of study of the so-called *tension-lines* between forest and prairie for example. Certain remarkable peculiarities of a tension-line population are pointed out and it is sought to establish a law of ejection from the depths of formations, by the action of which the tension-line would become the area of the distinctively newer or weaker types, and of the types in a highly variable or plastic condition. On pp. 602 and seq. the probable physiognomy of the Cretaceous period is discussed in the light of the tension-line analysis. It is argued that the preponderance of metaspermic leaves in the rocks by no means indicates a preponderance of metaspermic plants in Cretaceous forests, but indeed quite the reverse, since it shows that the metaspermic plants were in the proximity of the sandy beaches and mud flats, consequently in the tension-line position and probably, therefore, established only as narrow, highly variable fringes of ejected plants but with great central masses of cycadean, coniferous and probably older types of species forming the isolated bulk of the forest population.

From this study of the ancient physiognomy in the light of modern plant-formations a highly ingenious theory of the apparent suddenness of appearance of metaspermic forms and their great variability is developed. A new link between palæophytology and modern geographical botany is indicated, the further examination of which may be productive of most interesting results. This interesting and valuable report forcibly illustrates the interdependence of the natural sciences.

Distribution of Stone Implements in the Tide-water country. W. H. HOLMES. (From the American Anthropologist, Vol. VI, pp. 1-14.)

Mr. Holmes has introduced a new classification of aboriginal or prehistoric stone implements. It has been customary, following Mr. James Geikie, of Scotland, to designate as "paleolithic" many rude, evidently chipped stones which have been found in Europe and America, these being considered as evidence of very low grade of human ingenuity and skill, and as "neolithic" those chipped stones whose finish indicates that they had a definite purpose, completely attained, and shows in their maker a degree of skill equal at least to that of the historical aborigines of this country. It has also been *presumed*, in this country, following again Geikie's determinations in Europe, that the "paleoliths" were characteristically found in gravel beds, resulting from the disintegration and rapid withdrawal of the ice of the last glacial epoch, and that, therefore, their makers were pre-glacial or inter-glacial men. The "neoliths" were, therefore, all classed as post-glacial. This has been at least a working hypothesis in America for about twenty years, and several "finds" have been reported which tended to establish, as interpreted by the fortunate finders, the truth of this generalization.

Mr. Holmes, after long and careful search, which has been carried to several parts of the country where the stone-chipping people must have lived, whether in pre-glacial or post-glacial time, has come to the conclusion that some other explanation is necessary for the occurrence of "paleoliths" He is very skeptical as to the actual occurrence of any human relics in the true glacial gravels in this country, and hence as to the existence of man in the United States prior to the last glacial epoch. He finds the "paleoliths" mingled with "neoliths" at the sites of the quarries, where extensive working must have been carried on. They were plainly produced at one and the same time by the same people.

Therefore he conceives the hypothesis that the "paleoliths" are simply the rough material, as it was first rudely blocked out, either rejected outright, when not satisfactory, or cached for preservation, or perhaps carried from the quarry to some village site where they were wrought at leisure to perfect implements.

The paper discusses, in the light of this hypothesis, and illustrates by two plates, the distribution of both paleoliths and neoliths in the region of the Chesapeake bay, and particularly of the Potomac valley.

Note on Quartz-bearing gabbro in Maryland. U. S. GRANT. (From John's Hopkins University circular, No. 103, Feb. 1893.)

An interesting development of gabbro, in the vicinity of Wilmington, Del., northeast from Baltimore, has been described by professor F. D. Chester in Bul. 59, U. S. Geol. Sur. This has been found to contain notable amounts of quartz. Mr. Grant finds some of the gabbro in the immediate vicinity of Baltimore also contains from one-tenth to one-third of the whole rock of quartz. The grains are macroscopic, allotriomorphic, blue and original in the rock. He suggests that the basic Baltimore gabbro is genetically and chronologically the same rock mass as the acid Wilmington gabbro-granite.

Brown coal and lignite of Texas. E. T. DUMBLE. Report of the Geological Survey of Texas. Royal octavo, 243 pp., plates and map. Austin, 1892.

This work consists of a review of the qualities, classes, origin and uses of brown coals and lignite, with special adaptations to the case of Texas. Mr. Dumble visited Europe for the purpose and made careful studies of the methods of using such fuel. The volume contains much valuable information on that subject, with ample illustrations of furnaces suited for the combustion of brown coal and briquettes. A chapter is devoted to the geology of the brown coal deposits of the Eocene, and another to the occurrence and composition of the same. After a comparison of the Texas products with those of several countries in Europe, he reaches the conclusion that the Texas brown coals will supply an abundant material for fuel which will be both effective and cheap.

CORRESPONDENCE.

THE GLACIAL GEOLOGY OF MARTHA'S VINEYARD COMPARED WITH THAT OF LONG ISLAND. It is only recently that I had the pleasure of reading professor Shaler's report on the geology of Martha's Vineyard, published in the seventh annual report of the U.S. Geological Survey, and I was struck with the similarity between it and Long Island, including the plain country, as the professor calls it, south of the frontal moraine. In regard to the latter he is correct as to its origin, but at fault, I think, in the conjecture that the stratified deposits composing it were laid down beneath the waters of the sea. I am aware that its counterpart, the south side of Long Island, has always been considered a dereliction from the ocean, but after years of careful study I have failed to discover anything marine in its composition. A few shells are said to have been found in digging wells, but a diligent search for years on the part of the present writer, has failed to reveal the slightest evidence of marine matter in these stratified deposits. I presume it is the same with the plain country of Martha's Vineyard, and I cannot conceive how streams laded with detritus could mingle with the waters of the ocean and maintain a separate existence. Professor Shaler, however, thinks this is possible. He says: "At first sight, it may seem unlikely that the streams when poured into the sea, should be able to scour out channels for a mile or more beyond the ice front, but a similar work is performed where surface rivers enter the sea over the part of an extensive delta, though their currents were less rapid than those of sub-glacial streams urged as those streams were to their point of escape by the presence of ice as by the gravitative force given by their descent from the inland district." The professor is more competent to treat of this than the present writer; but I am very confident that future investigation will show that he is in error, at least, in regard to the presence of the ocean at the time when the plain country was being formed by subglacial streams. Nor is there any evidence of oscillation having taken place on these islands since the glacial age. I know it is difficult to explain the different phenomena on any other hypothesis, but some other explanation must be found.

It is held, that Long Island existed as a littoral plain in preglacial times, and that the old shore line was some ninety miles south of the present ocean beach, and that the land stood higher than now. Might it not have been *that the sea level was lower?* The melting of the great continental ice-sheets must have had some effect on the ocean. The well at Woodhaven on the south side of Long Island reached the underlying rock at a depth of 500 feet below the present level of the sea, which is the depth of the Hudson river gorge where it reaches the old shore line. Admitting that the Island had sunk this much in postglacial times, it is not likely that the subsidence

took place all at once, allowing the water of the ocean to flood the whole Island, for in this case we would have to provide for another elevation followed by a second subsidence, of which there is no proof whatever, unless it be in the stratified deposits of the north side of the Island which reach the altitude of 260 feet at Harbor Hill, but we know that such deposits can be formed by subglacial streams without an oscillation of land. It seems to me that the sea is nearer to our door than it ever has been since it overflowed its ancient boundary already referred to.

The Island remains very much the same as it came from the hand of the glacier, the only change being made by the inroads of the sea along the coast. There is not so much sinking as a wearing away of the superficial deposits of which the Island is chiefly composed.

As the sea invades the land, bays become part of the ocean, marshes become bays and swamps marshes; and this accounts for stumps of trees being found under water; for some of the swamps and other depressions go down below the present level of the ocean, and where the land barrier, which protects them, has been swept away, the trees, which grew in them, of course become submerged.

That these marsh lands existed at one time south of the present sea beach is evident from the quantities of turf that are washed upon shore during heavy storms. It seems certain that the streams that laid down the stratified deposits on the south side of Long Island and Martha's Vineyard came from the mainland; I think I was the first to notice this fact, and it seems to be confirmed by professor Shaler as he says in his report: "That the material transported by subglacial streams, and accumulated in the kame and terrace deposits, was transported for a greater distance than the detritus that was carried in the body of the ice."

This fact has not been sufficiently noticed in treating of the geology of Long Island, as it explains much that otherwise remains obscure. I claim that the indentations and bay depressions on the north side of Long Island owe their origin to subglacial streams, and not to spurs of ice as maintained by Dr. F. J. H. Merrill, late of Columbia College.* I have traced the connections of these streams from the sound to the sea, and while it is difficult to follow them in all of their ramifications, yet their relationship can be proven, I think, beyond all question. The connection, of course, is now lost between the Island and the mainland, but the corresponding depressions on both sides of the sound suggest, if they do not imply, that they were at one time united. They must have been, of course, if it be true that the subglacial streams came from the mainland. Martha's Vineyard has the same bay indentations on the north ending in ponds or marshy depressions as on Long Island. Professor Shaler sees some relationship between them and the kame and terrace formations of the plain country on the south, and he notices the same fact, which I have often

*See his paper on the Geology of Long Island. Annals of New York Acad. of Science, Vol. III, 1884.

spoken of in treating of the drift phenomena of Long Island, that where the frontal moraine is broken, these southern kames become more prominent, and these gaps always occur in the moraine where the streams come up from the north. In places there will be only a line of kettle-holes to mark the ancient line of drainage, and in other places as at Hempstead the moraine is nearly swept away. The old channels are always visible south of the ridge, but the depressions are mostly dry until nearing the bays on the south, where they are kept open by the tides or are fed by springs like the Seatuck river which flows into Moriches bay. This river is only about a mile in length, yet the old channel is traceable to the front of the moraine nearly four miles distant.

I mention these facts as they may tend to throw some light on the formation of both islands, for it seems to the present writer that the surface portions at least are all one as to time and origin.

Professor Shaler has observed very closely, but he has failed, I think, to fully understand the imports and connections of the old sub-glacial currents with the mainland, and their effect on the contour of the whole Island, for, studied in this light, I cannot see how any one can conjecture that any disturbance has taken place in postglacial or interglacial times, or that the sea held sway over any part of the Island during the deposition of the glacial detritus.

Eastport, L. I., N. Y., Nov. 29, 1892. JOHN BRYSON.

REMARKS ON A PART OF THE REVIEW OF THE THIRD TEXAS REPORT.— Although I was not connected in any way with the review of the Third Annual Report of the Geological Survey of Texas, published in the November number of THE AMERICAN GEOLOGIST, pp. 311-313, I beg the permission to say, that it is a fair and exact exposition of the Third Texas Report, and I fully indorse what the reviewer said about the geology of Tucumcari and Pyramid mount.

Mr. Robt. T. Hill's letter published in the December number, pp. 333-334, contests the statement that my "determination of the Jurassic age of the Tucumcari beds in New Mexico has been sustained by Capt. C. E. Dutton, Prof. A. Hyatt and himself, and opposed by Prof. Jas. Hall and Dr. J. S. Newberry;" and he goes so far as to protest against the use of those names "in a manner unauthorized" by Messrs. Dutton, Hyatt and himself.

Major Dutton has used my determination of the Jurassic in New Mexico, on the Zuni plateau and round mount Taylor, based on the discovery I made first at the Tucumcari region, and carried westward through the valley of the Rio Grande. The same area west of the Rio Grande surveyed by me in 1853, was resurveyed several years after by Messrs. Newberry and Gilbert; and both published geological maps, entirely devoid of the Jurassic formation. So in that part of New Mexico, major Dutton has sustained my determination of the Jurassic, as I first found it at the Tucumcari. No authorization is wanted to allow any one to quote the paper of major Dutton.

Prof. A. Hyatt has not published yet anything on his exploration, of a part of the Tucumcari region, in 1889. In conversation with me he said: "The fauna he has collected is an upper Jurassic fauna." He did not ask me to keep it as a secret, and I did not ask him the authorization to use his opinion in any of my papers. However I refrained carefully to quote his view, if I remember right, for I cannot find anywhere in my publications a reference to Prof. Hyatt's expressed opinion. In private letters, I may have said, that Prof. Hyatt agreed with me on the Jurassic age of the Tucumcari rocks; and I do not see any harm in the author of the review to have given the name of Prof. Hyatt, as having sustained my opinion. If Prof. Hyatt publishes his observations and comes to a different conclusion, he can correct his first opinion, which although not recorded in print, was certainly expressed in words to me.

Now Prof. Robt. T. Hill's part in the question is rather curious, for it is erratic in the extreme. First he published the 18th of November, 1888, the following paragraph: "The reaffirmation of the age of the Tucumcari section . . . to be uppermost Jurassic, as originally described by Marcou." Then in April, 1892, he gave another conclusion upon the geology of Tucumcari, as follows: "The writer has twice visited the mesa Tucumcari. . . The table or summit described by Capt. Simpson is covered with the typical Llano Estacado formation. . . Below this is a vertical escarpment of 50 feet or more of typical Dakota sandstone, resting upon loose sands and clays, forming a slope identical in aspect and fossil remains with the Denison beds of the Washita division. . . . Beneath this is a large deposit of the typical Trinity sands country, of white pack-sands, thin clay seams, and flagstones, while the base is composed of the typical vermilion sandy clays of the Red beds."

Although all is *typical* according to Mr. Hill, it is nevertheless difficult to see clearly what he means, for he gives no practical section of a single locality, like my section at Pyramid mount: no fossils of any sort are quoted, no place even on the whole area is named for an observation, and the thickness, stratigraphy and even lithology are all confused. If placed in a tabular view, in order to try to understand Mr. Hill's conclusions, we have the following stratigraphic series:

Mr. Hill's Series of 1892.	Marcou's Series of 1853.
50 feet or more of typical Dakota sandstone.	G. White limestone, 2 feet. F.—Yellow calcareous sandstone, 50 feet.
Loose sands and clays identical with the Denison beds of the Washita Division. No thickness.	E.—Blue clay with *Gryphoa tucumcari* and *Ostrea marshii*, 30 feet.
Large deposit of typical Trinity sands, with pack sands, thin clay seams and flagstone. No thickness given	D. C. and B. White and yellow sandstones, 113 feet.
Typical vermilion sandy clays of the Red beds. No thickness given.	Variegated marls of the Keuper or Upper Trias, 500 feet.

The upper part, corresponding to my divisions G. and F. of Pyramid mount, is referred by Mr. Hill to the typical Dakota sandstone, which means the lower part of the true chalk or Upper Cretaceous. As he gives no list of fossils, it is impossible to compare it with the typical Dakota sandstone of Nebraska. The middle part, corresponding to my division E. with the *Gryphæa tucumcari* and *Ostrea marshii*, is referred by Mr. Hill, to his Denison beds of his Washita division, that is to say, to his uppermost part of what he calls his Lower Cretaceous. No list of fossils is given, so it is impossible to know if the *Gryphæa tucumcari* and *Ostrea marshii* have been found by him at Denison, and to compare the fauna of the Tucumcari with the fauna of Denison.

The lower part, corresponding to my divisions D. C. and B., is referred by Mr. Hill to the typical Trinity sands. No list of fossils is given for the Trinity sands of Texas, nor for the Trinity sands of Tucumcari.

As a whole, the conclusion arrived at, in 1892, by Mr. Hill, is the reaffirmation of the age of the Tucumcari section, to be Nebraska Cretaceous, as originally described by Mr. James Hall, in 1857.

Between those two reaffirmations, one Jurassic and the other Cretaceous, and both without any paleontological, stratigraphical and lithological proofs; it is rather perplexing to know on what ground and on what observations Mr. Hill has based his conflicting opinions.

According to Mr. Hill the Tucumcari region is an "inaccessible locality." So it was when I visited it in 1853; but since 1887 it is easily accessible, for it has been visited twice by Mr. Hill and once each by Messrs. Hyatt, I. C. Russell and Cummins.

The method of correlation employed by me was to give names of the fossils discovered and their relations with typical European fossils; and as soon as practicable I had the fossils figured and published as early as 1855, two years after my exploration, and I described them with details in 1858; so, in less than five years every proof was given in full, with geological map and sections, notwithstanding the great difficulties of having my papers published first in French in Paris, and afterward in English at Zurich (Switzerland).

Mr. Hill acts differently, and his method of correlation consists simply in reaffirmation of the conclusions of others, without giving any proofs or even any reasons for so doing.

Incorrect paleontology and inexact stratigraphy and lithology have been used constantly against my observations. Is it too much to ask my opponents to publish soon a complete monograph of the Tucumcari region? Under rather difficult circumstances I have contributed my pioneer share to the knowledge of the geology of a country absolutely unknown until my exploration of 1853. Now it is their turn to publish what they have seen and found. JULES MARCOU.

Cambridge, Mass., Dec. 16, 1892.

Relation of the Attenuated Drift Border to the Outer Moraine in Ohio. I am much surprised at a statement which Prof. Wright makes in the February GEOLOGIST concerning the relation of the oldest moraine which I have traced in Ohio to the attenuated border of the drift sheet, the statement being that my studies support his view that the fringe is but an appendage of the moraine. The error contained in this statement is so great that I must beg leave to correct it by calling attention to the following facts:

1st. The moraine in question lies back from fifteen to forty miles from the glacial boundary and the interval between the moraine and glacial boundary is in the main an elevated district covered with till and not with overwash material. Both the width of the interval and the character of the drift material forbid our considering this sheet of drift a dependency of the moraine.

2d. The course of the moraine in southwestern Ohio is not at all in harmony with that of the glacial boundary, there being a re-entrant angle in the moraine opposite a southward protrusion of the boundary, and a protrusion of the moraine opposite a re-entrant angle in the boundary, a lack of harmony which causes the distance between the moraine and the boundary to range from fifteen miles up to fully forty miles. (The distance between the glacial boundary and this moraine is found to be far greater upon tracing the moraine westward, being in Illinois at least 120 miles.)

3d. The deposition of the outer sheet of drift is separated from that of the moraine by a time interval as great as has yet been found anywhere in the complex series of glacial deposits within the eastern half of the Mississippi basin. This time interval involves, (a) The development of a soil attended by oxidation, leaching, and erosion of the surface of the extra-morainic drift. (b) A depression of the region from a level apparently as great as the present (800 to 1,000 feet A. T.) down to a level within the reach of flooded stages of the streams, there being upon the eroded and weathered surface of the uplands a silt deposit several feet in depth, locally known as white clay, which is to all appearance a water deposit. (c) A re-elevation to an altitude as great as the present accompanied by great erosion of the loess and associated silts along the principal drainage lines, after which deposits of coarse gravel were made by the glacial floods which occurred at the time when the morainic line under discussion was occupied by the ice-sheet and which lead down the valleys at levels far below (300 to 400 feet) the level of the upland silts just mentioned.

In other words there were between the time when the ice-sheet reached the glacial boundary and the time when the moraine under discussion was formed three distinct depositions separated from each other by long intervals marked by considerable orographic movements as well as by soil accumulation, oxidation and erosion. In view of these facts I cannot support Prof. Wright in the statement that my studies bring corroborative evidence of his view that the old drift sheet outside the moraine is but an appendage of it.

Prof. Wright's statement also conveys the idea that throughout the entire width of the glaciated district moraines which lie nearest the glacial boundary are necessarily contemporaneous. Prof. Chamberlin long since called attention to the fact that the moraine which lies near the glacial boundary in eastern Ohio departs from the boundary in south central Ohio, and that in regions farther west there are other moraines lying outside this moraine. It has been his effort through his own investigations and those of his associates to trace out carefully the entire system of moraines and determine what their exact correlations may be. Precise correlations are yet to be shown but the facts at command make it necessary to dissent strongly from Prof. Wright's view. In Ohio the outer moraine of the southwestern portion of the state is not the outer moraine of the eastern and central portions, it being lost to view beneath the later moraine above referred to before reaching the Scioto valley. In Indiana and Illinois still greater shifting and overriding took place, a later group of moraines crossing an earlier group at high angles. This later group may prove to be the correlative of the outer belt of moraines in eastern Ohio and western Pennsylvania but upon this point final judgment cannot be rendered until the moraines are given further study. Enough has perhaps been said to make it evident that the complexity of the drift deposits and the difficulties of correlation are far greater than Prof. Wright has represented. FRANK LEVERETT.

4103 Grand Boulevard, Chicago, Ill., Feb. 6, 1893.

THE ILLINOIS STATE MUSEUM. I beg to thank you for your courteous comment on the work of the Illinois State Museum in the last issue of the AMERICAN GEOLOGIST.

In justice to several prominent scientists, who have gratuitously rendered important services to the Museum by revising our collections of Illinois fossils to be exhibited at the Columbian Exposition, I wish to add to the names mentioned in your article, the following, viz.: Prof. James Hall, who has revised all our brachiopods; Mr. Charles Wachsmuth, the crinoids. Dr. C. Rominger, the corals; Mr. David White, the Coal Measure plants; Mr. J. M. Clarke, the trilobites; Dr. Ch. E. Beecher, the Ceratiocaridæ; Dr. C. A. White, the Cretaceous and Tertiary mollusca; Prof. E. D. Cope, the Tertiary fishes; Prof. Milton Whitney is now preparing a report on mechanical analyses of a large series of soils of the state; captain A. W. Vogdes has prepared a bibliography of publications on the palæontology of Illinois, and Prof. J. M. Nickles, of Sparta, Ill, volunteered his last summer vacation in constructing a longitudinal section from East St. Louis to Shawneetown, and collecting samples of all the strata outcropping along this line. I hope to have still other names to add to this list before the opening of the Exposition. It would be but fair to add that a large share of the work has been ably done by Prof. J. A. Udden of Augustana College, Rock Island. Ill., and by Wm. F. Nicholson, both of whom have been employed by the Illinois Board

of World's Fair Commissioners to assist me in preparing the exhibits. Prof. Udden has had charge of the construction of a section across the state from Rock Island through La Salle to the Indiana state line, and Mr. Nicholson has, since July, 1891, assisted me in all the various works in the office, besides doing some field work in Union, Alexander and Calhoun counties.

JOSUA LINDAHL.

PERSONAL AND SCIENTIFIC NEWS.

THE IOWA ACADEMY OF SCIENCES held its annual meeting at Cedar Rapids, Iowa, on the 27th and 28th of December, 1892. The geological papers were: (1) *The Relation of the Cretaceous Deposits of Iowa* to the *Subdivisions of the Cretaceous proposed by Meek and Hayden*, and (2) *Note on the Structure and probable Affinities of Cerionites dactyloides* Owen, by S. Calvin, (3) *Natural Gas and Oil in Iowa*, and (4) *Some Mineralogical Notes*, by C. R. Keyes, (5) *From Ford to Winterset*, by J. L. Tilton. The other papers were chiefly biological. The Academy is fortunate in that the legislature, at its last meeting, provided for the publication of the papers and proceedings at the expense of the State.

Prof. L. H. Pammel, of the Iowa Agricultural College, was elected President, and Herbert Osborn, Secretary and Treasurer. The President of the Academy is *ex-officio* a member of the Board having control of the new Geological Survey of Iowa.

GEIKIEITE AND BADDELEYITE: TWO NEW MINERALS FROM CEYLON. The former, in the shape of pebbles, is a magnesian titanite. The latter is crystallized zirconia and is named after the collector, J. Baddeley.

A NEW METEORITE. A meteoric body of an estimated weight of twenty tons fell in the vicinity of Jiminez, Chihuahua, Mexico, about four months ago and is now in the Mexican Museum. In its fall this enormous body struck the side of a cliff, uncovering a rich vein of silver ore.

THE KANSAS BOARD OF AGRICULTURE has appointed Prof. C. S. Prosser of Washburn College, one of the geologists of the Board. Notwithstanding there is no authorized geological survey of that state in progress, there is prospect that the explorations of Prof. Prosser will result in considerable additions to our knowledge of its geology, for he intends to enter upon a season's work in the regions of the Carboniferous and Permo-Carboniferous.

THE STATE COLLEGE OF KENTUCKY, Lexington, has just established for the first time the department of Geology, and A. M. Miller is the first incumbent.

THE ANNUAL GEOLOGICAL EXPEDITION from the Johns Hopkins University, will take place between May 20th and June 10th. The excursion will cross the Piedmont plateau and the Appalachians. The ancient volcanics and the Cambrian sandstones of South mountain will be examined, also the great fault between the upper and lower Silurian strata at Cherry run, on the Potomac. Parties desiring to participate should communicate with Prof. G. H. Williams.

MR. JOHN EYERMAN HAS PRESENTED to the Princeton Museum a set of casts of *Rhytina gigas* Linn. after the originals in the British Museum. The number of casts is 20, that of the cranium, measuring 2¼ feet, being the largest.

ON NOV. 14TH, BEFORE THE NEW YORK ACADEMY OF SCIENCES, Mr. A. Hollock described some additions to the palæobotany of the Cretaceous on Staten Island. Dr. H. F. Osborn, "The Cretaceous Mammalia in the Museum of Natural History, Central Park," exhibiting some new material just received. Mr. Bashford Dean showed a new Cladodont shark from the Cleveland shales.

On Nov. 21st, Dr. Osborn delivered an illustrated lecture on "The Rise of the Mammalia."

On Dec. 21st, Dr. J. L. Wortman discussed the Mammalian Fauna of the Lower Miocene of White River. Dr. Osborn, "A New Artiodactyl from the Lower Miocene."

ON FEB. 13TH, DR. E. D. COPE DELIVERED a lecture before the Franklin Institute of Philadelphia on "Late Additions to our Knowledge of the Evolution of the Mammalia and Man."

DIED. DR. W. H. MELVILLE, chemist, of the Geological Survey of Texas, died suddenly of heart disease on Friday, Feb. 17, 1893.

SIR RICHARD OWEN, K. C. B., M. D., D. C. L., LL. D., F. R. S., F. L. S., F. G. S. (L. & E.), died at his residence in Richmond Park, London, at the age of 88 years. For over half a century this celebrated anatomist worked as a leader in the field of vertebrate palæontology and his communications number many hundred. Some of his best known studies are "Descriptive and Illustrated Catalogue of the Hunterian Collections" (published in 1840 after 12 years of preparation), "On *Trichina spiralis*," "Anatomy of the Vertebrates," "Odontography," "Description of Fossil Reptiles of South Africa," "Researches on Fossil Mammalia of Australia and Fossil Marsupials of England," "The Extinct Birds of New Zealand," "On the Megatherium," "Reptilia of the Wealden and Purbeck," "Reptilia of the Cretaceous," "On the Aye-Aye." He was for many years Director of the Hunterian Museum, and later, Director of the British Museum of Natural History.

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VESTIGES OF EARLY MAN IN MINNESOTA.

By W. H. HOLMES, Washington, D. C.

Of the various sites reputed to have furnished evidence of the former presence of glacial man in America, Trenton, New Jersey, has always taken precedence and is still the focal point of interest to students of the question. Next in importance, so far as the literature of the subject indicates, is the site at Little Falls, Minnesota. Observations began at Trenton about the year 1885, and a very considerable number of finds were reported, and the case in favor of a paleolithic gravel man was well formulated before the late Miss Franc E. Babbitt made her report upon the discovery of specimens of rudely flaked quartzes in the village of Little Falls. Attention had been called to the Minnesota site, however, before Trenton came into notice, by professor N. H. Winchell, state geologist of Minnesota, to whom belongs the credit of the discovery of relics of human handicraft in Little Falls as well as the credit of accurate and complete observation of the occurrence of objects of flaked quartz in the superficial glacial deposits. In the year 1877, in making a reconnoissance of Morrison county he spent several days in the vicinity and made the interesting observations recorded in the following paragraphs quoted from the sixth annual report of the state survey. In looking for evidence of what was known as "Pike's Stockade,"

about two miles below Little Falls, on the east side of the river he observed, to quote his exact words:

"Pieces of chipped white quartz, which from their sharpness, and their color, indicate an artificial origin, and attract the eye of the visitor. It was only after a handful had been gathered, that at last an imperfect arrow-head was found. These chips, at this point, were found only over a small area, indeed they were not looked for at other points up or down the river, nor at any depth below the surface. This quartz, which is white and opaque, was evidently taken from some vein in the slate in this neighborhood, for the slate at Little Falls has several veins of that kind of quartz.

"Subsequently, however, these chips were found to extend over a larger area, and to be incorporated with the materials of the river banks. * * * * They are found, not only on the surface of the flat on which Little Falls village stands, especially near the river, but on excavating the bank near the river, making a perpendicular section, they are found to extend downward three or four feet into the sand and gravel. A person in digging half an hour might find twenty-five or thirty. The material in which they occur is a homogeneous sand, passing downward gradually into a coarse sand and finally into a gravel. This flat along the river on the margin of which they are found, is about twenty-seven feet above the river, and is now never covered by it. The bank itself may be divided into three parts, as follows, in descending order: 1. Loam sand, gravelly below. 2. Gravel, becoming stony below. 3. Hardpan-drift, containing bowlders.* * * *

"The quartz chips occur in No. 3 [of the section on p. 55], and abundantly on the flat (somewhat lower than the average here) directly opposite Little Falls, in the neighborhood of the trap dyke. They extend up and down the river also an unknown distance. They were found at the mouth of the Little Elk, two and a half miles above Little Falls. The belt on the west side which seems to afford them is about 40 or 50 rods wide, but something less than ¼ mile on the east side. On the west side they appear in the soil when large trees tear it up."† * * * * *

"When they were first observed they were taken to be of much later date than they seem to be, indeed they were associated with the builders of the mounds and ridges that are seen at Little Falls and many other places in Minnesota, attributable to a race known as the Mound-Builders, who preceded the present Indian races. But these mounds and ridges at Little Falls are built of the very sand, and are situated on the very same plain in which these chips occur. In other words, the Mound-Builders dwelt at Little Falls since the spreading of the material of the plain; hence they are post-glacial. The chipping races, if these chips are of human origin, preceded the spreading of the material of the plain, and must have been pre-glacial; since the

*Winchell, N. H., Sixth Annual Report Minn. Geol. Survey, p. 54. †Ibid. p. 56.

plain was spread out by that flood-stage of the Mississippi river that existed during the prevalence of the ice period, or resulted from the dissolution of the glacial winter. The fortunate juxtaposition of these two classes of human remains enables us to establish this important general truth."*

My own observations confirm, in every respect, those of professor Winchell, but the examination of other groups of related phenomena makes it necessary to revise his inferences and conclusions. Finding relics of art deeply imbedded in the loam capping the terrace, he inferred that the site was occupied by men during the closing episodes of the glacial period, and coupling this idea with the fact that the shaped relics were all extremely rude he further inferred that the culture of that time must have been paleolithic. My investigations have shown, however, that the flaked quartzes were probably not originally included in the loam but rather that they were introduced into it in post-glacial times, and that they were rude because mere shop refuse, the period of occupation thus, in all probability, corresponding to that of our historic aborigines. In these views professor Winchell now fully acquiesces.

Several years later Miss Babbitt engaged in investigations at this place. Finding numerous flaked quartzes outcropping along the terrace front near the base, she assumed that the deposit was interbedded with the gravels at this level and inferred that man must have occupied the site early in the gravel forming epoch. Being unable to explain the fact that the flaked objects were all of rude types without supposing an exclusively rude state of art, she was led to assign them to a paleolithic culture. My researches make it plain, however, that the original observations were vitally defective and that the inferences and conclusions are wholly unsupported.

Miss Babbitt was a teacher, resident temporarily in Little Falls, and devoted much attention to the collection of archeologic data. Her first report upon the finds of flaked quartz was read before the Minnesota Historical Society in 1880, but nothing seems to have been printed at that time. A fuller account was presented at the meeting of the American Association in Minneapolis in 1883, an abstract appearing in the proceedings. In the American Naturalist for 1884† an extended paper was given embody-

*Ibid. p. 56.

†Franc E. Babbitt. Vestiges of Glacial Man in Minnesota. American Naturalist, Vol. XVIII, p. 594.

ing all the observations and deductions relating to the subject.

I will not quote from the writings of Miss Babbitt, save in so far as may be necessary to convey a clear notion of what she says upon vital points, and shall only do this when the reference is essential in explaining the relations of her observations to my own.

Besides the above mentioned investigations of professor Winchell and Miss Babbitt, no work has been done upon the archeology of this region, although other writers, notably Mr. Warren Upham, professor G. F. Wright, and Mr. Henry W. Haynes, taking for granted the correctness of all the original observations and conclusions, have ventured to enlarge upon the material published.

Professor Winchell revisited Little Falls at the period of Miss Babbitt's later investigations and accompanied her to the site of her finds. He did not attempt, however, on this occasion to do more than examine the surface phenomena at the "notch" and, although not fully satisfied with the deductions of Miss Babbitt, did not enter into the further discussion of the subject.

In returning from the copper mines of Isle Royale in June, 1892, I paid a visit to Little Falls and had the great good fortune to be joined by professor Winchell, who identified for me the site of his original discoveries as well as that of the subsequent investigations of Miss Babbitt.

Before describing my work at the latter point I will sketch briefly the general archeologic features of the vicinity presenting the results of such observations as bear directly upon the questions of the age and character of the flaked quartzes. The Mississippi river in this part of its course flows in a somewhat sinuous channel cut to a depth of from twenty to forty feet through a glacial terrace. Until a few years ago the river descended in a succession of rapids through what is now Little Falls village. A dam twenty feet in hight was built across the lower end of the rapid in 1888, and this has backed the water up for a consider able distance, drowning the banks to depths decreasing gradually with the distance from the dam. The main terrace has a rather even surface which rises from ten to twenty feet above the level of the back water. A limited bench, a post-glacial flood plain, on the west side, is several feet lower. The place affords an ideal

site for settlement either by savage or civilized communities. The occupation of the terraces adjoining the rapids by our historic aborigines was natural and inevitable, and I began at once to seek evidence of their presence, hoping readily to secure material for a comparison of their arts and industries with the reputed works of the ice age. Village sites were easily found on the terraces adjoining the lower end of the former cascades, one on the east side occurring on the remnant of a subordinate bench at the end of the dam and another on the west side three or four hundred yards farther down.

The western village was located on the post-glacial flood plain, and was manifestly recent, the site being covered with clusters of fire-marked stones—boiling or hearth stones—and with flaked quartz-refuse and hammerstones of ordinary types. The entire surface was grassed over and observations could not be readily made save on the banks of the river and in gullies cut by mill-race overflows. On the surface of the terrace perhaps one hundred and fifty yards below the west abutment of the dam, a wagon trail had cut the sod, exposing a nest of quartz fragments, which I dug out, finding them to be the usual quartz shop refuse consisting of flakes, partly shaped rejects and angular masses. The cluster was some three or four feet in horizontal extent and two or three inches deep in the middle, thinning out at the margins. It had not been seriously disturbed since left by the arrow-maker, save perhaps that such large pieces of stone as projected above the sod had been removed. In the side of a deep wash just below the lower mill, and between three and four hundred yards below the dam, the section of a similar shop cluster was exposed. There was visible in the vertical bank only a band of white chips, two or three inches deep in the middle and thinning out at the edges as in the other case, the deposit being covered by an inch or two of soil. Working this material out carefully with a hand pick, I secured about a peck of the ordinary quartz refuse and two pitted stones; the latter were found near what was originally the middle of the shop, just as left by the artisan who did the work.

These stones are both quartzite bowlders. The larger is but imperfectly rounded, being rudely pyramidal. It is six inches long and four in greatest thickness. One flattish side is deeply pitted by pecking, and the opposite side is slightly roughened by the same process. The pointed end is battered, indicating that

the object was used as a hammerstone, the pits accommodating the thumb and opposing finger. The smaller stone is irregularly discoid, is three and one-half inches in greatest diameter and one and a quarter inches thick. The sides are rudely pitted. The pecking has been done with a sharp stone carelessly used and the depressions are very rough to the finger tips. The margin or periphery is slightly battered by use. The occurrence of these two pitted stones of such varying size on a simple shop site furnishing no large fragments of quartz, led to the surmise that possibly the larger was a kind of anvil upon which the quartz fragments were placed to be splintered by the smaller stone. Both may, however, be simple hammerstones. The essential observation in regard to them as well as to the clusters of splintered quartz is that all are evidently of modern aboriginal origin.

On a somewhat higher level about half a mile above the dam, near a large lumber mill, I found another shop cluster of like character, the fragments being distributed to somewhat greater depth through disturbance of the original bed. Near by was a small artificially discoid hammerstone of granite.

These shop clusters all contain the ordinary flakes, fragments and rejects of blade-making, characteristic of quartz shop-refuse in all parts of the country. The ground on the west side of the river, wherever disturbed by plow, pick or wheel, is found to contain more or less fragmental quartz of corresponding forms. It was apparent that the supply of raw material was easily and generally accessible, and I soon found that over a large part of the secondary flood plain the alluvial deposits are very shallow, being underlain by Huronian slates through which run numerous heavy veins of quartz. A trench from two to four feet deep carried along a newly laid railroad track, a few rods back from the river, exposed many of these veins and white workable masses of quartz were scattered about in profusion. These ancient formations rise considerably above the present level of the back-water and certainly reach to within eight or ten feet of the surface level of the main glacial terrace. This fact, it seems, had not been previously observed. The only well marked village site found on the east side of the river is located on the remnant of a subordinate terrace which connects with the abutment of the great dam. The terrace is from three to six feet above the water of the dam, and falls off abruptly below some twenty feet to a lower level. Originally there

was here on this camp site a slight convexity of the surface, the result, no doubt, of building up of kitchen-midden material. The remnant of this accumulation is occupied by a blacksmith shop and could not be thoroughly examined. A section exposed by recent repairs to the dam shows about eighteen inches of dark soil filled with quartz fragments, charcoal and decayed refuse, resting upon stratified gravels. The latter are apparently only a few feet deep and rest upon the quartz-vein-bearing slates, of which excellent outcrops are seen in the bank below. The main terrace lies about one hundred feet back and rises six or eight feet above the village-site level.

The location and character of this site would seem to show conclusively that it was occupied in comparatively recent times. Many of the quartz bits and masses are partially shaped as in other places where implements were made. No other works of art were found. Quartz veins are exposed in the banks and bed of the river below the dam and on Mill island opposite, and I am informed by professor Winchell that large and conspicuous outcrops of quartz-veins were to be seen, before the dam was built, in the slates forming the bed of the rapids above. Considerable quartz flaking was done at various points along the bank of the river for nearly a mile down.

On Oak street, two or three hundred feet northeast of the village-site midden, I found an interesting shop cluster. The street is sunk a few feet into the level terrace exposing the surface deposits of sandy loam and making a section of the cluster of quartz shop-refuse; it was seen that this deposit did not lie in a horizontal bed just beneath the surface, as in the cases observed on the west side of the river, but that portions of it were disturbed, the fragments being distributed through the soil to a depth of a foot or more by some agency not clearly apparent. At other points near by I observed isolated and widely disseminated flakes projecting from the bank down to a foot or two beneath the surface. On the river bank three or four hundred feet farther north, and near the foot of Elm street is the site of professor Winchell's original discovery of flaked quartzes distributed through the loam. This portion of the terrace, lying about the eastern entrance to the bridge, has been much occupied by the aborigines and is strewn with flakes and fragments of quartz.

Further evidence of the modern occupation of the terraces

about Little Falls is found in the presence of mounds and earthworks and in the discovery of arrow points of quartz and other ordinary Indian implements. From these varied observations it is plainly seen that this locality was extensively occupied by our historic tribes, and the evidence is ample that they made free use of the quartz, outcropping at so many points, and that the refuse resulting from the manufacture of their implements is identical in every way with the relics obtained by professor Winchell and Miss Babbitt.

I paid my first visit to the site of Miss Babbitt's well known investigations in company with professor Winchell and Mr. W. W. Williams, of Little Falls, and the former identified and pointed out the exact spot on which the finds were made. So far as can now be seen the conformation of the ground is accurately described by Miss Babbitt, although since the period of her studies the river has been much altered by a dam and at this point the water has been raised eight or ten feet. The chief change produced is the entire drowning of the lower flood plain, which, if I am correctly informed, extended from near the base of the bluff several hundred feet outward to the margin of the main channel. A little farther down the outer and higher portion of this plane is still visible during periods of low water and is known as Boom island. It is, or was, separated from the present shore—the main bluff face—by a shallow channel. The water now rises to within an average of about twelve feet of the summit of this bluff, washing the slope a little below the level of the supposed outcrop of artificial quartzes.

At this point a shallow water-way or wash called the "notch," by Miss Babbitt and formerly occupied as a wagon road, leads obliquely down the slope to the water's edge. Before the dam was built ferry boats landed at a lower level, and in aboriginal times this spot was no doubt the upper end of a portage by means of which the rapids were avoided. Save for this break the bluff is continuous for a long distance, rising in places at a steep angle, but having at this point a slope of perhaps twenty or twenty-five degrees; the old roadway has a more gentle inclination. The accompanying sketch map conveys a clear notion of the topography of the spot and indicates the nature and extent of my trenching operations.

It was observed that the sloping sides of the shallow roadway

were somewhat freshly broken down exposing the black surface loam a few inches thick and portions of the yellowish sandy loam beneath. The former finds of flaked quartz were made mainly at x x, fig. 1, just above where the water now washes the northern bank of the roadway, and I found many specimens projecting from the soil at this point; but examination developed the fact, not observed by Miss Babbitt, that others were present, though more sparingly, in the dark loam on both sides of the roadway all the way up. I began a trench at the water's edge, as indicated by the heavy dotted lines, and carried it into the terrace, descending at intervals two or three feet below the water level. On the submerged slope as far below water level as it

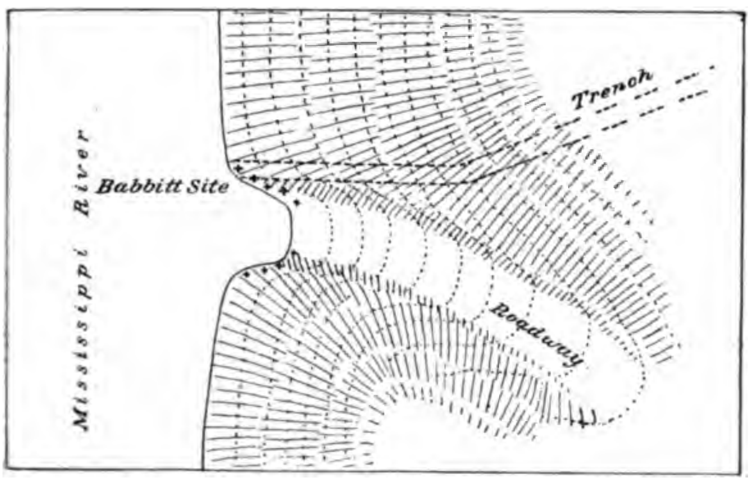

FIG. 1. Sketch map of the quartz shop described by Miss Babbitt. The heavier deposit of quartzes is at x x x. The heavy dotted lines indicate the position of my trench.

could be examined, the quartzes were apparently confined pretty much to the surface. The main deposit of shaped pieces, the Babbitt bed, rested upon a bed of nearly pure sand sloping gently upward from the water level.

As the trench advanced large numbers of the quartz fragments were encountered and it was observed that they corresponded closely in every way with those described and illustrated by Miss Babbitt and with those found upon and near the surface on the river banks below. There were in the deposit considerable masses of white quartz, just as they were derived from the veins, smaller fragments, bits, flakes and many partially shaped pieces

evidently the rejects of blade-making. I had for three years been familiar with identical quartz shop-refuse. These articles were embedded in rather loose heterogeneous gravels and though confined to a pretty uniform level below, resting upon a bed of sand, they extended upward to the surface of the slope. They were distributed somewhat generally throughout the mass, although a slight appearance of clustering was at times noticeable. As we penetrated farther the fragments became less numerous and included fewer large pieces. Having advanced about twenty feet on a line nearly parallel with the north bank of the roadway the formations began to change their appearance at the base and it soon became apparent that we had reached the limit of the heterogeneous quartz-bearing deposits, here some five feet deep, and were encountering homogeneous undisturbed strata, the separa-

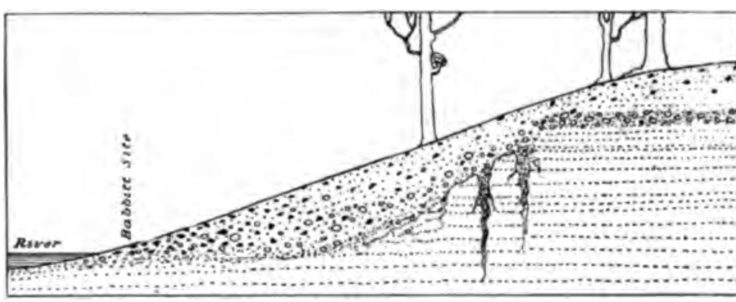

FIG. 2. General section of terrace margin, Babbitt site, showing bedded gravels and quartz-bearing talus, the black angular figures representing the artificial material.

tion being, however, quite indefinite. There was a somewhat gradual change of color and composition; from dark heterogeneous materials there was a gradation through mottled, mixed materials to yellowish, homogeneous, gravelly sands. The surface or front of these sands, referred to usually as gravels, rose at a high angle, and at thirty feet advance in the trench the superficial quartz-containing deposit had, from five feet deep at the 22d foot, thinned out to eighteen inches. The section presented in fig. 2. was drawn with great care and represents the general conditions with all necessary accuracy and without distortion of scale.

The phenomena of the front surface of the normal gravels as exposed in the trench were very instructive. There had been considerable disturbance by cracking and sinking, especially on

the side next the bank of the roadway. In this disturbed portion a few bits of quartz were found, and to the unskilled observer these might have been considered original inclusions in the gravel; but professor Winchell was present and gave his opinion freely that they were there through disturbances indicated by the mixed coloration. A little further on, at about the 32d foot, we came upon the root of a tree, the tap root of an oak, still preserved up to the dark soil of the surface, here some twelve inches thick, and extending down through the strata below the water level, an observed depth of six or seven feet. Having partly rotted, the root was surrounded by blackish earth. Further on a similar root was encountered which had penetrated to like depth, but which was almost totally decayed. The space was filled with blackish sandy

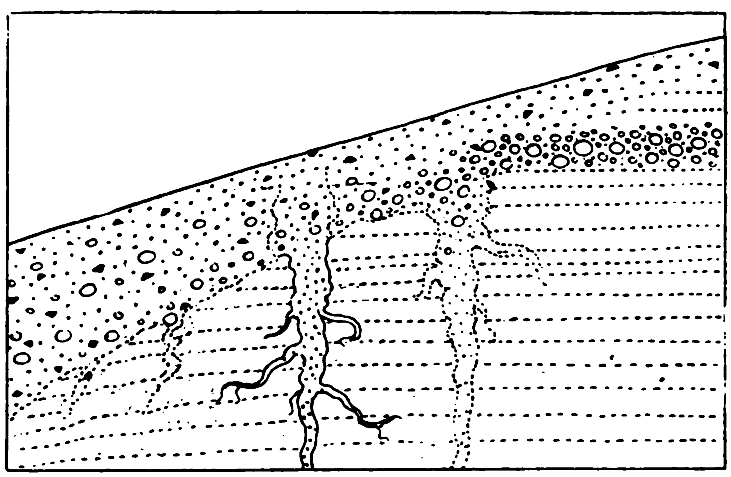

Fig. 3. Detailed section of talus and normal gravels, showing disturbances by crumbling and sliding, and by growth and decay of oak roots.

loam containing to some depth bits of gravel descended from the surface beds of heterogeneous materials.

In the normal deposits beyond these roots there was no trace of disturbance or of abnormal discoloration; neither was there a trace of flaked quartz, although hours of patient search were expended upon the full exposure of the undisturbed deposits extending to a foot or more below the water level.

As indicated in the accompanying sections, a layer of bowlder-bearing gravel several inches thick, occurs at about five feet be-

low the terrace surface. On the terrace slope at this level the surface loam, containing flaked quartz, was only a few inches thick; this condition is accounted for by the fact that the bowlder gravel, being firmer than the sands above and below, resists erosion and tends to form an outcrop, the loose materials from above descending to lower levels. Upon the layer of gravel rests about five feet of light brownish sand or sandy loam, somewhat darker near the surface from the decay of vegetable matter. A line of pits was carried across the level terrace, in continuation of the trench, to test the nature and contents of this deposit. In every pit, for more than one hundred feet from the margin of the terrace, shaped quartzes were found, and strangely enough, they appeared to be somewhat uniformly distributed through the loam to the depth of from two to three and a half feet. This was a repetition of the interesting phenomena observed by professor Winchell one-half a mile below; but before taking up this division of the subject I shall look more fully into the main source of controversy, the Babbitt finds.

The results of my own observations of the phenomena of this site are clearly presented in the accompanying sections, figs. 2 and 3. The glacial formations concerned consist of three members, first, beginning at the top, about five feet of sandy loam; second, a layer from six to twelve inches thick, of bowlder-bearing gravel, and third, a deposit of rather homogeneous sand with some fine gravel, extending down to two or three feet below water level, an exposed thickness of about eight feet. The face of these deposits is rather steep and is hidden by accumulations formed of materials weathered from the projecting edges of the strata. The talus deposits are only a few inches thick on the upper part of the slope but reach about five feet in thickness toward the base, as already shown, the terrace slope just here having an angle of from fifteen to twenty degrees. The whole of this talus deposit, from top to bottom, is filled with the refuse of quartz-arrow making, the heavier deposits of fragments occurring near the base, as shown in fig. 2.

The geologic, topographic and ethnic story of this site, read in the simplest manner from carefully observed data is about as follows: The formations constituting the river terrace, as indicated above, were, at the close of the glacial epoch, in the main continuous across the valley. The post-glacial river cut its

channel down through these deposits, reaching finally its present bed in the Huronian slates upon which the gravels were laid down. When the river flowed actively along the east side of the channel, washing the base of this bluff, the latter was no doubt much steeper than now and had a hight of about twenty-five feet. The horizontal glacial deposits were exposed to their full thickness, and in all probability, relying upon observations made in the vicinity, the underlying quartz-bearing slates at the base were uncovered to the depth of from five to ten feet. When the river ceased to erode actively at this point, the loosely bedded gravels and sands forming the upper part of the bluff disintegrated and descended to the base, covering the slates and the exposed edges of the formations and gradually producing the practically stable slope seen to-day.

The primitive inhabitants of the valley sought quartz whereever the veins were conveniently exposed. Finding at this point a natural descent to the river by a gully, now the old roadway, they were able to reach the exposures of quartz, and naturally established their shops on the nearest available spots. It is probable that the wide flood plain now under water was in those earlier days swept by strong freshet currents exposing the quartz-bearing formations over large areas, thus furnishing unusual opportunities to the quartz-working natives. These are precisely the conditions that prevailed in the river channel in front of the old village site at the dam, as shown by a photograph of the place made before the dam was built. Even if exposures of quartz were not found at the lower end of the "notch" they certainly did occur in the river banks a few hundred feet away, since at the present time, with a rise of ten feet in the water level, the quartz-bearing rocks are still exposed in the opposite bank of the river. Professor Winchell is of the opinion that in early times this spot was probably the only convenient or available landing place near the head of the rapids, since the banks elsewhere were either steep or swampy; and it is not improbable that quartz, obtained about the head of the rapids or even at the mouth of Elk river above, where veins occur, was brought to this spot in canoes and broken up and trimmed prior to further transportation. That the source of the quartz, or part of it, was really near at hand is attested by the presence of masses and fragments of considerable size on this site, and it seems highly probable that when these work-

shops were occupied by the arrow-makers the quartz-veins were exposed somewhere within easy reach of the base of the "notch" and possibly within a few steps of the heavier accumulations of shop refuse; but whether this be the case or not, the mystery of the origin of the quartz, dwelt upon by the original explorer, entirely disappears.

I may mention that there is a very common misunderstanding in regard to the accumulation of this class of shop refuse. Because it is plentiful and scattered over a considerable area, a long period and vast numbers of people are predicated, but so far as this site is concerned—and I speak from careful observation—one old arrow-maker, with a couple of squaws to gather the quartz, would in a few weeks produce as much refuse of manufacture as has ever been seen upon this site.

Approaching this subject, this particular group of phenomena, from my own standpoint—that acquired by a study of quarry-shop work and of the general conditions of modern aboriginal life—no other theory than that outlined above seems called for, and no other known theory will satisfactorily explain the facts as brought out by the study of the site; but there are those who may wish to understand how Miss Babbitt, who examined the spot with much particularity and dwelt at great length upon the phenomena, was able to reach such opposite and remarkable conclusions.

In order that the matter may be more readily examined by students I beg leave to present brief extracts from her writings, in which are embodied most of the essential points of her observations and interpretations. Having carefully described the site and the occurrence of quartz fragments and artificial forms, she states her objections to a recent and neolithic origin for the quartzes, arguing that the phenomena could only be reasonably accounted for by assuming that the quartz was flaked and distributed during the accumulation of the gravels and before the pre-glacial, outcropping veins were buried by the rapidly accumulating deposits; and inferring that the artificial forms, being exclusively rude are, without doubt, paleolithic. Having formulated these views it remained only to assume that the river in cutting its post-glacial channel had exposed and disturbed the artificial deposits, leaving them as found to-day. The following arguments are given in support of the positions taken:

"The spot appeared to be peculiarly unfitted by nature for a base

of quartz-working operations. It was unintelligible, for example, why an important industry of this sort should have been established at so great a distance from quartz bowlders and quartz-bearing rock, especially as convenient plains occur about the nearest exposures of this mineral. Again, why should such a manufactory have been set up upon a steep hill-side with its approaches of such a character that all the material to be handled, as also the implements fashioned, would have to be transported to and fro, up and down a considerable acclivity? Above all, why should this workshop have been relegated to the bottom of a natural drain, the solid contents of which were necessarily overwhelmed, or swept away bodily, at every considerable rainfall and thaw of the year? As an illustration of the superficial disturbance to which the place was subject, I may mention that at the close of a long, but by no means exceptionally protracted rain-storm, I once collected from the notch, by actual count, about one thousand quartzes, all newly plowed out of the soil at that one time. Of this I was certain, as I had previously cleared the ground of every quartz piece of any size from view.

"A final fact, wholly irreconcilable with the hypothesis of neolithic origin, was the absence of quartzes from the surfaces at the superior edges of the notch, and along the terrace-plain adjoining. It was not for a moment to be believed that such remains would have been thus distributed by aboriginal artificers. It was simply impossible that the quartz-workers should have limited their manipulations to a strip of sand six or eight feet wide and thirty to forty long, less or more, heaping upon this narrow defile thousands upon thousands of fragments, yet leaving absolutely no small splinters nor chips beyond, neither up the slopes of the notch nor elsewhere in the vicinity. * * *

"Prolonged investigation ensued, establishing the hitherto unsuspected fact that the notch quartzes could never have been directly involved in the terrace surfaces. Had they once been thus inhumed, the superficial stratum of adjacent drift would assuredly have been found to contain a greater or less poporrtion of similar fragments, scattered throughout its substance. But this was not the case. On the contrary, no buried quartzes whatever appeared in the superior exposures of the notch; nor within the horizontal surfaces at either hand, though such were sought with careful scrutiny. * * *

"The absence of chips above a plane a foot or two superior to that of their bed at the bottom of the notch was, of course, a marked circumstance, since they should have occurred plentifully in the superficial stratum, had the notch chips been, as assumed, of the same age with professor Winchell's find."*

In the light of what I have already said and expressed in the section given, figs. 2 and 3, it would seem unnecessary to comment upon these extracts as the misapprehensions embodied in them must at once be apparent to the discriminating student; but a few points may be briefly referred to. The statements in the first paragraph quoted, that the site must have been distant from the source of supply of the raw material and that it was, on account of its topography, wholly unfitted for shop work are, as I have shown, entirely invalid. In speaking of the agencies that wash out and transport the quartzes the author reveals accidentally one reason for their occurrence in a bed at the mouth of the "notch," for it was through this washing out and through the action of gravitation that portions at least of the products of the scattered shops on the slopes and terrace margin above were carried down to this spot. At the same time this was probably the natural location for the main shop, the spot where all masses of large size would be broken up and assorted, since it may have been the only approximately level ground about the landing at the base of the terrace. The argument against a modern origin for the quartzes based on peculiarities of distribution, falls through when the true conditions are known, these conditions being exactly such as would result from recent occupation of the river landing by our Indian tribes.

In the second, third, and fourth paragraphs it is emphatically denied, as an essential feature of her case, that flaked quartzes occur at any point above a horizon some twelve or fifteen feet lower than the main terrace level. This, as my careful dissections show, figs. 2 and 3, is entirely wrong. The deposit seen at this level was not interbedded with the gravels and was not a stratum. Apparently Miss Babbitt did not see the gravels in place and probably did not approach them within a distance of many feet of the level indicated. I have shown that the quartzes were not confined to a given level, but occur at all levels, not only on the surface but apparently in nearly every square yard

*Babbitt, Franc E. American Naturalist, Vol. XVIII, pp. 599-601.

of the surface loam within a radius of one hundred and fifty feet from the supposed bed of paleoliths. It is not necessary to dwell further upon these extracts or to review other parts of her work, for, notwithstanding Miss Babbitt's evident sincerity and prolonged and praiseworthy attempts to reach the truth, it should be plainly stated that had she deliberately planned to misunderstand and misinterpret the more important phenomena of the site she could hardly have been more successful in accomplishing these ends.

It is clear that the section exposed by my trench discloses exactly the conditions and phenomena that would result from the occupation of the site by quartz-workers of our neolithic aborigines at any period subsequent to the exposures of the Huronian bed rock by the post-glacial river, and there is nothing in the conditions and phenomena of the site that will enable us to say whether the beginning of the quartz-working dates back one hundred or one thousand years. Considering all features of the evidence, however, geologic, topographic, archeologic and historic, the probabilities are very strong that the former figure is more nearly correct than the latter.

Having shown that there is no evidence of the presence of man in this locality during the earlier stages of the gravel-forming epoch, the proposition affirmed by Miss Babbitt, I desire now to examine briefly the evidence relating to his presence during the final stages of that era, as outlined by professor Winchell. It has already been stated that the early observations of the occurrence of worked quartzes in the superficial glacial deposits are in every respect correct, and identical observations were made by me on the Babbit site in carrying the trench up over the level surface of the terrace. At all points within a radius of about one hundred and fifty feet from the Babbitt deposit the quartz fragments were distributed through the loam to the depth of from three to four feet. The same conditions were observed at other points, and I was at first entirely at a loss to account for the phenomena save on the theory, suggested by professor Winchell, that man lived upon the flood plain of the Father of Waters, at this point during later glacial times, shaping there his rude implements of quartz. But as my observations were continued and carried over a wider field I encountered facts that did not readily accommodate themselves to this theory, suggesting the need of

other explanations. Some of these puzzling facts may be enumerated.

In the first place, it seemed strange that the quartzes found in the loam should be confined exclusively to sites occupied or naturally resorted to by modern tribes who, as I have shown, left refuse identical in character and material with that found in the loam. In the second place, these quartzes were not in beds or layers at definite depths beneath the surface, as if made and used on the site at intervals in glacial inundation, or as if distributed from sites of manufacture by water during the formation of the deposits. It seemed a most significant fact that they were, in all observed cases, distributed somewhat uniformly through the stratum of sand extending from the surface downward, as if let into the deposit from above by some disturbing agency. In the third place, as professor Winchell has observed,* there were, so far as can be determined, no exposures of quartz-veins from which the raw material could be obtained at the period of gravel deposition involved; and, in the fourth place, professor Winchell had, at another point, secured neolithic implements from this same deposit.† So strongly were these suggestive observations impressed upon my mind that I felt impelled to begin the search for more definite evidence, and especially for evidence of agencies that could have served to introduce articles of modern make from the surface. Fortunately it was not necessary to go far. In digging the trench on the Babbitt site it was observed, as shown in fig. 3, that the rotting of the roots of large trees would permit the lowering of surface objects into the superficial deposits, and that as a result general distribution would in time result; but this did not seem to be a sufficiently potent agent. It was also apparent that distribution, such as that observed, would result from disturbances of the soil by burrowing animals, like the gopher, badger and prairie dog, by the wallowing of buffalo, by the cutting of paths by elk, and by excavations made by men, but these were not entirely satisfactory agencies, as they were not within the range of present observation. I passed up and down the margin of the terrace, examining each exposure of the strata and every contour of the bluff. I soon found that the winds had played with these surface sands and that dunes had

*Winchell, N. H., 6th An. Rept. Geol. Survey of Minn., p. 57.
†Ibid. p. 60.

accumulated in places to the depth of from three to five feet, giving rise to obscure elevations along the edge of the terrace; and it appeared that any part of the loam could thus have been worked over within recent times, distributing the bits of quartz from surface shops throughout the mass. Any one of these observations would have been sufficient to enable me seriously to call in question the conclusion that the quartzes were originally included in the loam, but I sought an agency entirely competent and satisfactory.

Passing through the western part of the village I came upon a large area recently cleared of its growth of young forest trees. The surface was varied by countless humps and hollows, and I found, by careful inspection, that it was the site of an ancient forest which had been uprooted by a tornado. A few of the great root masses were still preserved, and in some cases where the wood had entirely disappeared the mounds of earth were still three feet high and the associated pits or hollows were nearly that deep. The humps and pits were so numerous as to disturb nearly one-half of the original level surface of the ground, and the disturbance must have extended in many cases to a depth of from four to six feet. Here, evidently, was the distributing agency sought, and one entirely competent to accomplish all that had been observed of distribution. Not only was this much obvious, but it appeared, further, that a factory site upon which relics were distributed, disturbed by such an uprooting of forest trees, could not do otherwise than present exactly the conditions observed in the loams of the terrace plain. Indeed, it may be said that, in a locality where forests grow on and in deposits so unstable as are these Little Falls loams, it is impossible that surface accumulations of articles of stone should remain for a long period entirely upon the surface; and the explanation thus furnished of the distribution of the worked quartzes of this locality through the glacial deposits, to the depth of four feet or more, is so satisfactory that no other theories are called for and little further discussion seems necessary.

The processes of distribution of surface articles throughout the superficial loams by this agency may be illustrated by a series of sections. The section presented in fig. 4 exhibits the conditions of a cluster of shop sites such as had accumulated on the prairie margin when the manufacture of quartz implements was going

on. There may, or may not, have been a forest at the time without affecting the final result, although a longer period must be allowed if the forests had to grow after the site was deserted by

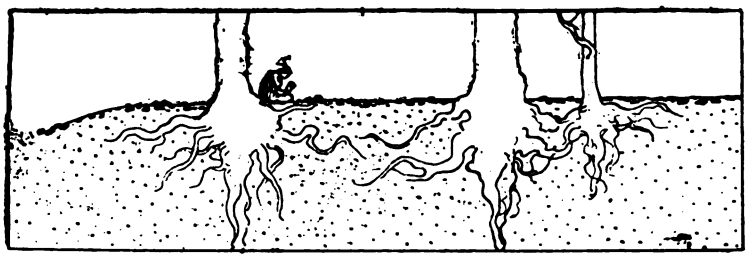

FIG. 4. Normal distribution of recent quartz shop-refuse upon the prairie surface, the black angular figures representing the refuse.

the arrow-makers. The immediate result of the uprooting of a forest upon such a site is depicted in fig. 5. Portions of the quartzes would descend into the pits and portions would be car-

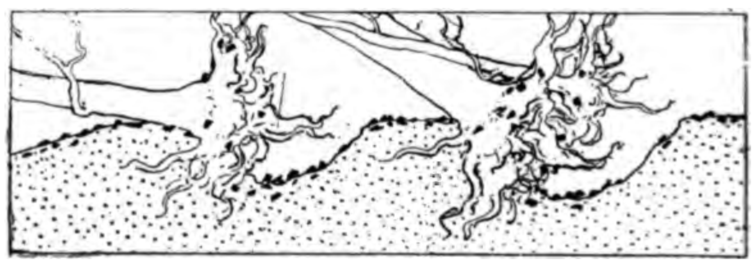

FIG. 5. The effect of uprooting of trees on surface relics.

ried up with the roots. When the wood rotted away the quartzes would be distributed over the mounds and in the hollows somewhat as shown in fig. 6, and by the time the elevated por-

FIG. 6. Distribution of quartzes over humps and in hollows after the rotting of uprooted trees.

tions of the soil had again settled into the general level of the prairie the conditions would be pretty much as indicated in fig.

7. This result is really most remarkable, yet, as I have shown, inevitable—time being allowed—under the conditions existing at Little Falls. It is seen that in the period occupied by the uprooting and decay of a forest and the settling of the loose earth back to its original level, the modern quarry-shop site with its

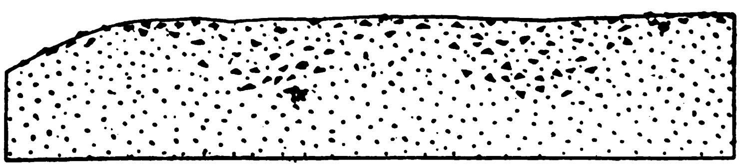

FIG. 7. Distribution of quartzes resulting from forest uprooting, exemplified in the surface deposits of Little Falls.

bed of fragments, flakes and failures may be so changed in character as to afford striking proof of a paleolithic man of glacial age. The record may be so altered in the period of a generation as to be read ten thousand years instead of fifty. Such is the magic of nature's transformations and such are the pitfalls set for unwary explorers. It is true that since the occupation of this site by the quartz flakers, many forests may have fallen, but proof of this must necessarily be hard to secure, and if secured must still fall short of carrying the history of man back to glacial times.

In support of the theory that man dwelt in the valley of the Mississippi some ten thousand years ago it is pointed out that artificial quartzes are distributed through portions of the superficial glacial deposits. I have shown that there are many ways in which this distribution could have taken place under modern conditions and through causes operating within the century. It may be objected that I have really proved nothing with respect to the recent introduction of the quartzes into the loams of this particular site, but I would observe that this is not essential. I have shown that the presence of worked quartzes in the unstratified, superficial loams furnishes no real support for the theory of a glacial man.

In the study of this site, three problems have come up for consideration, first, is there evidence of human occupation of this locality early in the gravel-forming era as deduced by Miss Bab-

bitt from the discovery of worked quartzes along the base of the terrace? second, is there evidence of man's presence at the close of the glacial epoch, as indicated by the occurrence of art forms distributed through the surface loams? and third, is there evidence that the art or any part of the art attributed to either of these horizons is paleolithic? All of these questions may be answered emphatically in the negative. It is clear from the facts presented in the preceding pages, that had a thoroughly careful and well directed study of the phenomena of the site been made in the first place, the first and last of these questions need never have arisen.

The mistakes made by Miss Babbitt are precisely such as others have made through taking up investigations in the geologic department of archeology without adequate knowledge either of the processes and phenomena of geology or of the arts and habits of our aboriginal peoples. It is manifestly easier to explain the puzzling phenomena of prehistoric archeology in America by current theories borrowed from foreign sources, than to attribute them to conditions and causes of which no knowledge has been acquired. Like mistakes are made to some extent by all students and at all stages of progress in research, and it must be regarded as a duty rather than as a charity to pass lightly over all such shortcomings in the work of genuine investigators; at the same time our highest duty is to science, and vital errors, no matter what their origin, should be unhesitatingly pointed out, and expunged from the records.

In closing, it may be stated with entire confidence that there is no available evidence of either a paleolithic man or glacial man in any part of the upper Mississippi valley. So far as my own observations and interpretations go, the vestiges of early man in Minnesota are confined exclusively to ordinary traces of Indian occupation. Considering the facts observed at Little Falls, and all the known ethnic phenomena of the region, this conclusion is so simple and natural that it ought to stand unquestioned until positive proofs to the contrary, proofs not yet foreshadowed, are brought forward and subjected to the tests of science.

[CONTINUED FROM PAGE 179.]

PLEISTOCENE PAPERS READ AT THE OTTAWA MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA.

Eskers near Rochester, N. Y. By WARREN UPHAM. A very remarkable esker, called the Pinnacle hills, extending about four miles in a west-southwest course on the southeastern border of the city of Rochester, and another esker series several miles farther southeast in Pittsford, were described in this paper and attributed to deposition by streams flowing down from the melting surface of the ice-sheet during its departure, their channels having been enclosed on each side by ice and open above to the sky. The material of these eskers, which was shown to have been englacial, is chiefly gravel and sand, but also comprises in some parts of the Pinnacle hills very abundant and large boulders, up to ten feet in diameter, some of which are lifted 200 feet or more above their sources within a few miles on a nearly plain country. The near origin of the Niagara limestone boulders in these hills was noticed in their earliest description, which, with the figure of a section, was published by Prof. James Hall fifty years ago. Probably no other locality has afforded so definite proof of transportation of drift into the lower part of the ice-sheet by currents having a considerable upward movement from a flat tract; but the angle of ascent may have been no more than one degree, or 92 feet per mile. An article by Mr. Charles R. Dryer, on the glacial geology of this region, with a map showing these eskers, is in the AMERICAN GEOLOGIST, for April, 1890.

President GILBERT and Secretary FAIRCHILD spoke briefly, in discussion of this paper, concerning their observations of the peculiar structural features of the Pinnacle hills, for which no detailed explanation had been previously attempted.

Comparison of Pleistocene and Present Ice-sheets. By WARREN UPHAM. The Pleistocene ice-sheets of North America and Europe were compared with the now existing Malaspina, Greenland, and Antarctic ice-sheets, as to their areas, surface slopes and probable thickness, rates of erosion and ablation, sub-glacial and englacial drift, and manner of deposition of the various drift formations. The Malaspina glacier or ice-sheet, covered on its wasting borders by much drift and growing forests, is believed to afford explana-

tions of forest beds between deposits of till, and of the peculiar drift accumulations named drumlins (as shown in the AMERICAN GEOLOGIST for December, 1892), both being attributable to stages in the general recession of the North American ice-sheet when increased snowfall and onflow of the ice slackened its retreat or caused it temporarily to re-advance. Under this view, the Ice age seems probably to have comprised only one great epoch of glaciation, with moderate oscillations of the ice-front, and to have been geologically brief. The length of the Post-glacial epoch, according to N. H. Winchell, Gilbert, Andrews, Wright. Prestwich, Mackintosh, and others, has been only about 6,000 to 10,000 years. In Europe Prof. James Geikie has shown that men had reached the neolithic stage of their development before the ice-sheet of Denmark and Scandinavia had vanished; and similarly in California neolithic implements, probably contemporaneous with the Ice age, are found in gravels under the lava of Table mountain. Other discoveries of stone implements, mostly of palæolithic types, and of the flakes formed in their manufacture, have been made by Dr. Abbott and Profs. Putnam and Shaler in the late glacial gravels of Trenton, N. J., by Mills and Metz in Ohio, by Miss Babbitt in Minnesota, by Tyrrell in a beach of the glacial lake Agassiz in Manitoba, and by McGee in the sediment of the last great flood of the Pleistocene lake Lahontan. Great elevation of the glaciated countries is believed by the author to have been the chief cause of the Ice age, and the pre-glacial uplifting probably occupied a longer time than the glaciation; but both may be well referred, as by Hilgard and Spencer, to the Quaternary era, which also, according to Dana and Sir Archibald Geikie, should be considered as extending to the present time. With this definition, the Quaternary era may comprise about 100,000 years.

Mr. MCGEE, in discussion, doubted the reference of the ice accumulation to high altitude of the land, and spoke of recent studies by Mr. W. H. Holmes at Trenton, N. J., who supposes all the evidences of man's presence there to be post-glacial.

Dr. A. R. C. SELWYN thought that the Pleistocene and present ce-sheets are most readily explained by changes in the course and volume of marine currents, and that glacialists should take into account various concurrent causes for the glacial climate

and diverse processes in different regions for the formation of the glacial and modified drift deposits.

Prof. WRIGHT remarked that Dr. Abbott in examining extensive railway excavations of the Trenton gravel had far more opportunity for the discovery of implements than Mr. Holmes in his recent observations, and that Prof. Putnam in several days' search found five stone implements there in the undisturbed glacial gravel. The implements found in Ohio by Mr. Mills and Dr. Metz are also entirely conclusive testimony of the presence of men contemporaneous with the departure of the ice-sheet. Any artificial flakes of stone, and "quarry rejects" or failures, are quite as good proofs of man's presence as finished implements.

Prof. SALISBURY would restrict the term englacial drift to the material borne along in the central and upper portions of the ice-sheet, which was scanty and of distant origin, while the basal portion of the ice contained much drift from near sources. He concurred with Mr. McGee in doubting the testimony which has been supposed to establish the existence of man on this continent during the Glacial period.

The post-glacial outlet of the Great Lakes through Lake Nipissing and the Mattawan River. By G. FREDERICK WRIGHT. Following the suggestion of Mr. Gilbert in his paper on the "History of the Niagara River," that the northeastward depression of the northeastern United States and the eastern provinces of Canada at the close of the Glacial period probably caused an outflow from lake Huron for some time by way of lake Nipissing and the Mattawan into the Ottawa river, Prof. Wright had during the past summer examined the course of the supposed outflow and found good evidence that it was a fact. Trout lake, at the head of the Mattawan river, is only three miles from lake Nipissing and is 20 feet higher; and the swamp on the divide between them is 20 feet, or less, above Trout lake, or about 100 feet above lake Huron and Georgian bay. On the north side of this swamp, a beach line or terrace was traced all the way from lake Nipissing to Trout lake, and is regarded as the level of the former outflow. The Mattawan in its length of about 30 miles descends some 200 feet, and on the south side of its mouth a terrace 80 feet above its junction with the Ottawa bears a surprising profusion of boulders of all sizes up to 20 and even 30 feet in

diameter. These boulders the author thought to have been swept down the Mattawan valley by a powerful river outflowing from lake Huron, as the debacle of discharge from lake Bonneville brought a similar multitude of boulders to Pocatello, where it entered the broad Snake river valley.

In discussion, President GILBERT stated that he had examined this divide and the course of the Mattawan to lake Talon, finding the avenue of drainage to consist largely of boulders, with scarcely any till or stratified beds.

Dr. BELL thought that all the reported observations fall far short of proving an outlet from Lake Huron to the Ottawa. The tract of so plentiful boulders at the mouth of the Mattawan he considered as part of a morainic belt.

On certain features in the distribution of the Columbia formation on the middle Atlantic slope. By N. H. DARTON. This paper, read in the absence of the author by Mr. McGee, directed attention to evidences of an interval of erosion between the two divisions of the Columbia formation in Maryland and northward to New Jersey. The lower division comprises beds of loam and fine and coarse gravel, all of which enclose occasional ice-borne boulders; and the upper division, more rarely containing boulders, consists chiefly of loam or clay, resembling loess, to which the name Philadelphia brick clay was given by Lewis. Both parts are referred to estuarine deposition, and the interval of emergence and erosion dividing them is thought to correspond to the inter-glacial epoch and forest bed of Iowa between deposits of till, which appear correllative with these lower and upper parts of the Columbia formation.

Mr. UPHAM, in discussion, thought the Columbia gravel and loam to be not marine or estuarine sediments, but the deposits of river floods bearing ice-rafts when the land in the early part of the Glacial period was higher than now, with much greater supply of detritus and of water from rains and snow melting each spring and summer.

Note on the geology of Middleton Island, Alaska. By GEORGE M. DAWSON. (The author being absent, this paper was read by Mr. R. W. ELLS.) On Middleton Island, situated near the verge of the submarine continental plateau, about 50 miles distant from the coast, typical till is found, enclosing abundant argillite fragments and broken marine shells. A microscopic examination also

reveals sponge spicules and several species of foraminifera. This island is apparently a part of a moraine of the continental ice-sheet, the shells and foraminifera being brought from the sea bottom between it and the mainland. The intervening water is from 30 to 50 fathoms deep, but when the ice-sheet was being formed and plowed up its drift, the region was probably much uplifted. Similar till containing shell fragments occurs also on the Queen Charlotte islands.

Mr. C. W. HAYES, discussing this paper, mentioned his observations of wave-cut terraces 30 feet above the sea on islands in Prince William sound, opposite to Middleton island, which show that for a long time following the glaciation of this part of Alaska, the land has stood so much below its present hight. This also agrees with the conclusions of Dr. W.H. Dall, that mainly the coasts of Alaska and of Bering strait are now slowly rising.

THE GEOGRAPHIC DEVELOPMENT OF THE EASTERN PART OF THE MISSISSIPPI DRAINAGE SYSTEM.*

BY LEWIS G. WESTGATE, Middletown, Conn.

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I. THE POST-CARBONIFEROUS DRAINAGE.

1. The post-Carboniferous drainage. The region of the Mississippi basin has at no period been subjected to such violent dis-

*The writer wishes to acknowledge his indebtedness to Prof. W. M. Davis, of Harvard college, for help and suggestions received during the preparation of this paper.

turbances as have characterized the region of the Appalachians on the east, or the Rocky mountains on the west. All changes seem to have been of the nature of continental elevation or subsidence, affecting wide areas. The principal effect of such movements upon rivers flowing over approximately horizontal rocks would be to increase or diminish their power of erosion with their greater or less elevation above base-level. Their courses would not be altered. It is therefore not improbable that the courses of the larger rivers and the general direction of the drainage of the area was determined at the time of the first elevation of the land above the sea at the close of Carboniferous time, and that this drainage has been maintained ever since. The drainage which was instituted when the interior basin first became dry land will be considered, and the courses that the streams then took determined, as far as possible. If the present courses of the streams correspond with these hypothetical original courses, the similarity may be explained by considering the first streams to have preserved their first courses. They will then be original or consequent streams. If there is a lack of correspondence between the two, the cause and date of the change from the supposed original courses must be considered.

During Paleozoic time the region of the Mississippi valley was occupied by a broad interior sea, bounded by land masses on the north and southeast. Sediments were brought down into this basin from either side. Sands and gravels were deposited near shore, finer muds at a distance, while the center of the basin was the scene of the accumulation of widespread limestone deposits. During Carboniferous time the sea shallowed, and its bottom over much of the area was near sea level. At times vast swampy forests grew over newly emerged flats, only to be buried beneath the mud and sand of a later subsidence.

There was of course no drainage while the area was under water. The drainage of the swamps of the coal period must have been very sluggish and is so little known that it cannot be considered here.* But it is comparatively easy to picture the conditions which must have existed over most of the area after the Appalachian disturbance. The Paleozoic rocks had been crumpled into mountain elevations along the Appalachian region. These folds died away to the west where the Carboniferous deposits formed a

*See Missouri Geological Survey. Report on Coal, 1891, pp. 24-5.

new and level plain sloping gradually away to the northwest. This slope was probably greater than the slope of the beds as they were deposited, for the beds doubtless shared more or less in the elevation which had taken place on their southeast margin. The drainage of this elevated mountain region would extend itself across this plain to the northwest, the direction of flow being determined by the slope of the surface. The crystallines of Canada and the Paleozoic sediments which had been forming in the sea south of them appear to have been elevated at about the same period, so that the whole of the eastern Mississippi basin became dry land. Whether the Canadian uplift was of continental extent and the present dip of the stratified rocks is merely the slope of the old Paleozoic sea bottom, or whether there was a differential uplift by which the northern portions were more elevated than the southern, is not known. In either case there would be a southward slope from the crystallines over the newly emerged plain. The southward drainage from the Canadian highlands and the northwestward drainage from the Appalachian region would unite and form a trunk stream flowing westward and occupying the position of the present Ohio. The Archean area of Wisconsin, which existed as an island in the old Paleozoic sea, formed a more or less elevated nucleus after emergence, with Paleozoic strata sloping away from it in all directions; and the drainage of Wisconsin would consist of streams flowing out radially from its Archean core. The outlet of all these streams,—of the trunk stream draining the Canadian and Appallachian regions, of the westward flowing streams from the Archean area of Wisconsin and from the Archean area to the north in Minnesota and British America,—would be to the west, discharging into a Mesozoic sea, the limits of which have not been determined.

It is now necessary to compare this hypothetical post-Carboniferous drainage of the eastern Mississippi basin with the present drainage. If the two are found to agree in whole or in part, that part of the present drainage which corresponds with the hypothetical post-Carboniferous drainage may be considered to have been determined in its general direction at the time of the Appalachian uplift. Where lack of correspondence between the two exists, the differences will be examined in detail.

Comparing the present with the supposed post-Carboniferous system, the rivers south of the Ohio are seen to flow northwest in

both cases. North of the Ohio and south of the St. Lawrence basin the direction is south in both instances. In Wisconsin the drainage is radially out from the central Archean area. The present drainage of the eastern Mississippi basin is therefore in the main that which may be assumed as the original consequent drainage of the region when the land was first elevated above the sea. In the absence of any evidence to the contrary, the most probable explanation of the coincidence is that the river courses in these parts of the Mississippi basin have remained in general unchanged since Permian time. They are here considered original or consequent streams.

2. *Adjustments of the post-Carboniferous drainage.* There are however several important differences between the hypothetical post-Carboniferous drainage and the present drainage, in which the present streams cannot be explained as original streams. They are as follows:—(a) The St. Lawrence drainage. (b) The drainage of the Silurian areas of Tennessee and of Ohio, *i. e.* of the Tennessee and Cincinnati anticlinals. (c) The course of the upper Mississippi. (d) The course of the lower Mississippi. These departures will now be considered.

(a) *The St. Lawrence drainage.* The most marked departure from the presumed post-Carboniferous drainage, is the drainage of the St. Lawrence Basin. The earliest consequent drainage of this area must have been southward from the crystallines of Canada to the Ohio. But the great drainage lines of the St. Lawrence basin, which are occupied by the great lakes and the rivers connecting them, are structural valleys developed along the strike of the softer members of the Paleozoic formations and at right angles to the slope of the original surface. This structural control of the drainage shows of itself that the present arrangement is not the consequent arrangement of the streams, but that it is an arrangement which was effected after the land had been long elevated above the sea. The streams had then had opportunity to cut down into the underlying strata and had slowly adjusted themselves to the differences in hardness and structure which they there discovered.

The cause and date of this change from the early consequent to the later subsequent drainage in the St. Lawrence basin have not been definitely determined. It is probable that the adjustment was effected during that long interval between Permian time

and the commencement of the Cretaceous cycle of which there is little record in the Mississippi basin. During this time the drainage was changed from the first condition in which the streams flowed down the slope and across the strike of the beds, to a condition where they followed the softer members of the Paleozoic rocks.

It is probable that the change in outlet from the Ohio to the St. Lawrence was effected at a later date and was one of the results of the elevation and tilting of the Cretaceous base-level, which will be considered later. After the general surface of eastern America had been reduced to a lowland under the action of long-continued erosion, a slight tilting of this lowland would be sufficient to divert a part of the Mississippi drainage northward through the lower St. Lawrence. If lake Michigan and lake Erie drained southward into the Ohio previous to the glacial period, the final completion of the present St. Lawrence drainage was not effected until the close of the ice invasion.

(b) *The drainage of the Cincinnati and Tennessee anticlinals.* In the discussion of the post-Carboniferous drainage two similar important structural features of the Mississippi basin were left out of consideration. These were the Cincinnati and Tennessee anticlinals, as they have been called. If these two regions were to have a surface form like that indicated by the geological structure, there would be a broad low dome over central Tennessee and a similar but much larger elevation over parts of Kentucky, Ohio and Indiana. If such elevations did exist they are ignored by the present Ohio and Cumberland rivers which cut directly across them.

The most probable explanation of this apparent peculiarity is that the anticlinals never existed as surface elevations at any time subsequent to the Appalachian elevation. Some considerable part of the arching of the strata took place during Paleozoic time, previous to the Appalachian uplift. The direction of the axis of disturbance is not parallel to the Appalachian axis of disturbance, but is more nearly north and south, suggesting an independent disturbance. There are evidences that during Paleozoic time shallow water or land conditions prevailed along the axis of uplift in Tennessee, Kentucky and Ohio. Ripple marks occur in the Devonian Black Shale in Ohio. Going south from lake Erie to Tennessee the Devonian and Upper Silurian succes-

sively become thinner and finally disappear, indicating that a land area existed in Tennessee and Kentucky in middle Paleozoic time which during a considerable period was gradually extending itself northward. The present anticlinal dip of the strata appears to be due to an elevation of middle Paleozoic date. Erosion in middle and late Paleozoic time was doubtless effective in removing a large part of the original constructional inequality. If then this low land mass had been slightly submerged during Carboniferous time and covered with a thin veneer of Carboniferous rocks, and had then been elevated with the rest of the interior basin, the post-Carboniferous drainage would have followed the course of the present Ohio and Cumberland rivers, directly across the underlying structural anticlinal, and at a later date would have discovered the concealed diversity of rock structure. The course of the Ohio and Cumberland rivers would be consequent upon the slope of the newly emerged land surface. In that part of their courses lying across the Cincinnati and Tennessee anticlinals, the rivers are superimposed on the underlying rocks from a cover of Carboniferous strata which have been completely removed.

(c) *The upper Mississippi.* The course of the Mississippi along the western border of Wisconsin affords another example of departure from the supposed post-Carboniferous drainage. Instead of flowing down the dip of the rocks to the southwest it follows the strike to the southeast. The original drainage of the area must have been southwest into a Mesozoic interior sea, and this drainage must have been maintained until the end of Cretaceous time; for during the Cretaceous period the interior sea reached almost as far east as the Mississippi. The elevation of the plains inaugurated a new condition of drainage. The elevation of the plains on the west and of the Appallachian region on the east which marked the close of the Cretaceous period, left a broad north and south depression which determined the course of the drainage of the northern part of the Mississippi basin, and the upper Mississippi dates from that elevation.

(*d.*) *The Lower Mississippi.* There is good reason to believe that the course of the main post-Carboniferous drainage line of the interior was not, as it is now, south from the mouth of the Ohio, but rather west, through Missouri and Arkansas. The axis of the trough which was formed between the Canadian and Appalachian uplifts would lie to the southwest, through Missouri

and Arkansas, —a continuation of the line of the present Ohio,— and it would seem as if the post-Carboniferous drainage of the interior would have discharged along this line.

Positive evidence for such a discharge is not wanting. Folded Paleozoic rocks occur in the Novaculite region of central western Arkansas* under conditions which pretty definitely show them to be a continuation of the Appalachian folding to the east. Silurian and Carboniferous rocks are embraced in the folding and the structure is closely similar to that of the folded Paleozoic rocks of the Appalachian region. The folds are closely appressed on the south side and flattened on the north side of the area, showing a pressure acting from the south. The prevalence of shales on the north side and of sandstones on the south side of the region indicates a derivation of material from the south. In these last two respects the Arkansas region resembles the Appalachian. The general trend of the folding in the Novaculite area is toward the east,—toward the point where the Appalachian folds disappear beneath the gulf Cretaceous. These facts clearly indicate a westward continuation into Arkansas of the Appalachian folding and elevation. In post-Carboniferous time a mountain barrier in all probability extended from New York to Arkansas, precluding the possibility of a southward discharge of the interior drainage by its present outlet, and compelling its discharge to the west, through Missouri and Arkansas. This may be taken as the probable direction of the main drainage line of the interior basin in post-Carboniferous time.

The change to the present southward drainage seems to have taken place at the end of the Cretaceous period. By that time the Appalachian mountains had been reduced nearly to base-level and probably existed as a low and nearly obliterated divide. When the elevation of the Cretaceous base-level occurred, the streams would have followed any troughs produced by the warping of the old lowland. The elevation of the Appalachians on the east and the plains on the west resulted in producing a broad north and south depression in the present Mississippi valley and in reversing the courses of those streams which had been flowing westward into the Mesozoic sea. But, perhaps, more important than the elevation of the plains in diverting the interior

*Geol. Survey of Ark., Ann. Rept., 1890, vol. III. Novaculites, by L. S. Griswold, pp. 212-214.

drainage southward was the actual depression of the Cretaceous base-level across the lower course of the present Mississippi river. Here the base-level was depressed below sea level and the drainage of the interior found an easy outlet to the south. Since that time the Mississippi has been gradually extending its mouth southward.

II. The Cretaceous Cycle.

1. The Cretaceous Cycle. The earliest topographic feature of eastern North America dates from the close of the Cretaceous.* It comprises the remnants of the plain to which long continued erosion of Mesozoic time had reduced the land surface. At the commencement of Tertiary time this lowland was raised and became an elevated upland plateau.

Two difficulties are met in the attempt to trace this elevated Cretaceous base-level across the Mississippi basin. First, erosion appears to have obliterated almost all evidence of it on the soft paleozoic rocks of the interior, and it is only on the borders of the region, where the rocks are prevailingly hard sandstones and conglomerates, that successful search for it may be expected. Second, over a large part of the Mississippi basin the topography of the underlying rock surface is concealed beneath a monotonous mantle of glacial drift.

2. The Cretaceous Cycle in Kentucky and Tennessee. Remnants of the Cretaceous base-level occur in Tennessee and Kentucky. Among the mountains of North Carolina evidence of the elevated Cretaceous base-level is found by Willis.† The mountains rise a few thousand feet above the plateau and some of the valleys are cut several hundred feet below it, but to a person standing at the same elevation with the plateau, its plateau character can be distinctly seen. The considerable elevation of the mountain summits above the plateau in this district is due to the greater hardness of the rocks which did not permit their being reduced to base-level before the elevation which closed the Cretaceous Cycle. Northwest of the Carolina mountains lies the broad valley of the East Tennessee river, which was excavated during Tertiary time. On its eastern border, the generally even crest-line of Pine mountain, with an average elevation of 2,000 feet probably marks the

*See Bull. Geol. Soc. America, vol. 2, pp. 541-586. The Geological Dates of Origin of Certain Topographic Forms on the Atlantic Slope of the United States, by W. M. Davis.

†National Geographic Magazine, vol. 1, 1889, pp. 291-300.

outcrop of the Carboniferous conglomerate upon the old base-level. Beyond the valley of the East Tennessee rises the Cumberland table-land, with an average elevation of 1,900 feet. The fact that its surface consists of the bevelled edges of strata of different hardness, shows that it is a plain of denudation. It is another remnant of the old base-level. It is a direct extension southward into Tennessee and Alabama of the plateau of western Pennsylvania, which has been identified by Davis as a part of the Cretaceous base-level. The western edge of the Cumberland table-land is bounded by an abrupt descent to a second plateau, which has an average elevation of 900 feet, and which extends to the west, completely encircling the central lowland region of Tennessee, as far as to the Tennessee river and a short distance beyond. This plain has been termed by Safford* "the highland rim of middle Tennessee." On the west this plateau runs beneath Cretaceous beds. The relative straight line of contact between the Cretaceous rocks and the Paleozoic rocks which compose the highland rim, and the fact that west of the line of contact no Paleozoic rocks are seen projecting through the Cretaceous cover shows that the Cretaceous beds were deposited upon a comparatively level surface. This level surface appears to be a part of the Cretaceous base-level which has already been recognized in the Cumberland table-land and among the Carolina mountains. A gradual rise from the western to the eastern part of the old base-level would be expected. Such is not the case. The two parts are not continuous, but there is an abrupt cliff separating the Cumberland plateau from the highland rim, of which the western edge has been considered a part of the Cretaceous base-level. The most probable explanation of the separation of the two parts is that which attributes it to later erosion. The elevation of the Cretaceous base-level at the end of Cretaceous time has permitted Tertiary erosion to cut out at a lower level a structural plain upon the hard siliceous sub-Carboniferous bed which forms the floor of the highland rim. The siliceous sub-Carboniferous rocks were the surface rocks of the Cretaceous base-level in western Tennessee, hence the Cretaceous base-level and the structural plain are identical there, where the Paleozoic rocks run beneath the Cretaceous. But in middle Tennessee the siliceous

*For a description of the physical features of Tennessee see Safford, Geology of Tennessee, pp. 21-125.

sub-Carboniferous beds were far below the Cretaceous base-level and after elevation Tertiary erosion removed the overlying limestone and shales down to the level of the siliceous beds, beneath which it did not go. The result was the separation of the old base-level into two parts, one represented by the Cumberland tableland, the other by the part of the highland rim where it runs beneath the Cretaceous.

3. The Cretaceous Cycle in Wisconsin. Throughout most of the area northwest of Tennessee and Kentucky, the surface configuration of the older rocks is concealed beneath a heavy mantle of drift. But over a considerable area of Wisconsin and a small part of the neighboring states, no drift deposits occur and the rock topography is visible. The general physical features of southern Wisconsin* embrace a widely opened lowland, trenched by water courses, and with remnants of a higher land mass rising above the general lowland and forming the inter-stream divides. The trenching of the general lowland, from analogy with similar work elsewhere, appears to be the work of Post-Tertiary erosion. The development of the general lowland took place during Tertiary time. The hills rising above the general lowland are the last remnants of the elevated land mass upon which erosion commenced at the beginning of Tertiary time. Whether the hight of these remnants represents the full altitude to which the land was elevated at the beginning of Tertiary time or whether erosion has everywhere reduced the country to a greater or less amount below the uplifted Cretaceous base-level, has not been determined. In any event, these higher masses represent nearly destroyed remnants of the Cretaceous elevated base-level; and even these remnants are probably not the full measure of the altitude assumed by the old lowland after its elevation at the end of the Cretaceous period.

4. The Cretaceous Cycle in Minnesota. The Cretaceous deposits of the plains reach eastward as a continuous sheet, to about the western border of Minnesota.† But at numerous localities in Minnesota, some almost as far east as the Mississippi river, isolated patches of Cretaceous occur beneath the drift, resting upon the underlying rock surface. These deposits are found along

*See U. S. Geol. Survey. Sixth Annual Report 1884 5. The Driftless Area of the Upper Mississippi Valley—T. C. Chamberlain and R. D. Salisbury. pp. 221-239.

† Geol. of Minnesota. Final Report, vol. I, pp. 431-439.

the stream lines, probably because the thick sheet of drift everywhere conceals the underlying rocks, except along the rivers. The rocks upon which they rest are often seen to be an eroded land surface. These facts show that the surface of Minnesota was nearly base-leveled when the Cretaceous beds were deposited. The surface of southern Minnesota is mostly level prairie formed by the drift. The Minnesota river cuts a trench in this prairie 125 to 200 feet deep, and in doing so cuts in places through Cretaceous beds and into the underlying rocks. The surface of the rocks upon which the Cretaceous beds lie must therefore be nearly level. It could not have been much more uneven at the time the Cretaceous beds were deposited upon it than it is at present, for any erosion which would have lowered the inequalities must have completely removed all the overlying softer Cretaceous deposits. Southern Minnesota therefore is considered to have been a nearly base-leveled country at the time that the Cretaceous deposits were laid down. The similarity between the present rock topography underlying the drift and the low relief of the land in Cretaceous time points to the conclusion that since Cretaceous time southern Minnesota has not been for any long period of time much elevated above base-level; consequently post-Cretaceous erosion has not destroyed the Cretaceous base-level in the process of reducing the country a second time to base-level.

5. *The Cretaceous cycle in Arkansas.* Evidence of the extension of the Cretaceous base-level into Arkansas has been given by Griswold.* The higher ridges of the novaculite area west of Little Rock reach an average elevation of 2,500 feet, perhaps marking the altitude of the upland from which the present topography has been cut. "Still further south the ridge tops become broader and the valleys shallower. The appearance of an upland plain becomes more marked as the elevation decreases southward and less opportunity is given for deep stream erosion. The southward sloping plain of Paleozoic rocks sinks below Cretaceous or Tertiary strata and none of these older rocks are seen again south of the contact line, projecting through the later sediments. This gives evidence that the Paleozoic strata of this region had been worn down to a pretty level surface before the Cretaceous strata were deposited. Thus we have altogether good

* Geol. Survey of Arkansas. Ann. Report, 1890, vol. III. Novaculites by L. S. Griswold. pp. 220-222.

evidence of a former base-level plain which is naturally less distinct toward the north where subsequent elevation and denudation have been greater." *

6. Completion of the Cretaceous Cycle. The elevation which closed the Cretaceous cycle of development was of late Cretaceous or early Tertiary date. The occurrence of Cretaceous rocks unconformably lying upon the elevated base-level at many points proves that the elevation could not have taken place until the end of Cretaceous time.

The date of the completion of the process of base-leveling was not the same in all places, but varied according to the hardness of the rocks. In New Jersey† the base-leveling of the Triassic area was completed before the deposition of the Cretaceous beds, *i. e.* by the end of Jurassic time. The Cretaceous beds here over-lie unconformably a plain formed of the beveled edges of inclined Triassic sandstones. The base-leveling of the harder crystalline rocks of the Highlands was not completed until the end of Cretaceous time, for the material composing the Cretaceous beds was largely derived from the highland crystallines. Over the interior basin the rocks are relatively soft and the Cretaceous base-level appears to have been essentially completed before the deposition of the Cretaceous beds. The elevation of the base level, however. did not take place until the Cretaceous rocks had been deposited.

The extension of the Cretaceous base-level over the eastern Mississippi basin has now been considered and remnants of it have been found in widely separated parts of the basin. Probably before the close of the Cretaceous period the whole of the eastern Mississippi was a lowland plain close to base-level, except in the southern Appalachian mountain region where the country may still have had considerable relief. The direction of the stream courses by which this erosion was accomplished has already been considered in discussing the post-Carboniferous drainage.

III. The Tertiary Cycle.

1. The elevation of the Cretaceous base-level. At the close of the Cretaceous or commencement of the Tertiary there was a general elevation and warping of the Cretaceous base-level over

* l. c., p. 221.

†Bull Geol. Soc. America, Vol. 2. The Geological Dates of Origin of Certain Topographic Forms on the Atlantic Slope of the United States —by W. M. Davis, pp. 554-5.

the whole of eastern North America. The amount of elevation was not the same in different parts of the area. The plateau now stands at an elevation of 1,300 feet in western New England, 1,600 feet in New York on the Hudson, and 2,500 feet in western Pennsylvania. These elevations represent in a general way the amount of Tertiary elevation and warping: for deformations of post-Tertiary date are of relatively small amount. Southwestward along the Appalachians the altitude of the plateau falls until in Georgia and Alabama it dips beneath the gulf Cretaceous and beneath the sea level as well; so that across the lower Mississippi there was no elevation, but an actual subsidence. In the upper Mississippi valley lack of recognizable remnants of the old plateau prevent an accurate determination of the elevation, but the amount was less toward the Mississippi and in Minnesota was probably of very little account.

By the elevation and warping of the Cretaceous base-level important changes were effected in the drainage of the eastern Mississippi basin. The elevation of the plains turned the drainage of a large part of the interior toward the east. All the rivers which now cross the plains date only from the early Tertiary, for during Cretaceous time the present area of the plains was beneath sea level. The Missouri and its tributaries are Tertiary rivers. The elevation of the plains on the west and the Appalachian area on the east formed a broad north and south depression which determined the course of the upper Mississippi; and, aided by the depression of the base-level across the present course of the lower Mississippi, turned the main drainage discharge of the interior southward by its present course to the gulf. The Mississippi, therefore, also dates only from the commencement of the Tertiary.

These changes in drainage were caused by the warping which accompanied the elevation of the old lowland rather than by the elevation itself. Upon rivers flowing over approximately horizontal rocks such as cover most of the Mississippi basin, the only effect of elevation alone would be to increase the erosive power of the streams; it would not alter their courses. A differential uplift or warping is necessary to cause a change in the direction of drainage courses.

With the elevation of the Cretaceous base-level the rivers began to cut down to a new base-level and entered upon a new cycle of development. This is the Tertiary cycle of development. With

the exception of the cases already instanced, the rivers seem to have held the courses which they had had during Cretaceous time; at least there is no evidence of change from those courses. The movement of elevation embraced so wide an area that it did not affect the minor arrangement of the stream courses. The streams of the Cretaceous cycle were revived. Elevation gave them greater velocity and erosive power and they at once commenced to cut their channels to base-level and then to widen them out at that level.

2. *Tertiary work in Tennessee and Kentucky.* The larger part of the topography of Tennessee and Kentucky was fashioned out from the Cretaceous base-level plateau during Tertiary time. The broad valley of the East Tennessee with an average elevation of 1,000 feet above sea level and cut a thousand or more feet below the surrounding plateau is a Tertiary valley. It is a direct southward continuation of the Kittatinny valley of New Jersey and Pennsylvania which is of Tertiary date. In western Tennessee the Tennessee river has excavated during Tertiary time a broad deep valley similar to its valley in eastern Tennessee but not as deep, for the altitude of the plateau is not so great as in eastern Tennessee.

A better illustration of the extent of Tertiary erosion is found in the central part of Tennessee. From the central lowland of Tennessee the strata dip away in all directions at low angles. If the strata which have been removed were to be restored the form of the surface would be a wide flat dome with its greatest elevation over the center of the region. The capping of Carboniferous rocks over this region may originally have been of less thickness than over surrounding regions. Whether pre-Tertiary erosion sufficed to strip off this cover of Carboniferous and sub-Carboniferous rocks and to expose the softer Silurian strata beneath is not known. In any event pre-Tertiary erosion must have considerably lessened its thickness and have made it easier for Tertiary erosion to complete its removal. The erosion of the present central lowland could not have been the work of Cretaceous time, for during Cretaceous time the base-level of the region was several hundred feet above the present surface. But after the elevation of the Cretaceous base-level and the establishing of a new base-level at a lower level, the streams soon cut through the thinned covering of Carboniferous and sub-Carboniferous rocks

to the soft Silurian limestone on which they then began to widen out the present lowland. At the same time that the central lowland was in process of formation, the shales and limestone were being removed from above the hard siliceous beds which form the rim of the central lowland region and a second and structural plain was being formed along the siliceous beds. This second plain is the "highland rim" of middle Tennessee, and is principally of Tertiary date, although reasons have been given for considering its western portion as a part of the Cretaceous base-level.

3. Tertiary work in Wisconsin. The surface of the driftless area of Wisconsin is generally level and if we leave out of consideration the trenching of the lowland by the present streams it may be considered as a region in which the surface has advanced far toward topographic old age. The streams have not only cut down to base-level, but have widened out their valleys laterally forming wider and wider plains and causing the intervening land masses to recede until they have become dendritic ridges, or isolated hills, or have wholly disappeared. The general surface is a broad plain interrupted by remains of a higher land mass which has been eroded away except along the divides. The excavation of this lowland was accomplished during Tertiary time. Since then the region has been slightly elevated and the streams have deepened their channels and trenched the general lowland; but this episode is of interglacial date and does not concern us here. Before this slight uplift the surface of the driftless area was that of a country approaching the close of a long geographical cycle in which it had been reduced to base-level except along the inter-stream divides.

4. Post-Tertiary sub-cycle. By the close of Tertiary time the softer rocks over many parts of the eastern Mississippi basin had a second time been base-leveled. The broad valley of the Tennessee river and the central lowland of Kentucky and of Tennessee and the level lowland of the driftless area of Wisconsin are the clearest examples of this lowland. In Minnesota the lowland of Tertiary time was the lowland of Cretaceous time.

After the close of Tertiary time a small elevation occurred which left the drainage of much of eastern United States a greater or less distance above base-level. The streams at once began to cut below the lowland which had been the base-level at the end of

Tertiary time. The resulting trenches can be recognized in many parts of the elevated region. The rivers of the middle Atlantic slope have cut trenches one, two or three hundred feet below the Tertiary base-level. The young narrow gorges of the upper Ohio and its branches cut into the earlier widely opened and mature valleys, described in Bulletin 58 of the Geological Survey by Chamberlain, are probably of the same date as the trenches of the rivers flowing into the Atlantic. The trench of the lower Mississippi as well as the trench of the upper Mississippi and the narrow valleys of the rivers which trench the Tertiary lowland of the driftless area of Wisconsin appear to be also of the same date.

This minor cycle can be recognized only along the larger rivers and along the lower courses of their tributaries. Remote from the main drainage lines and where Tertiary erosion had not reduced the river channels to base-level, the effect of elevation was simply to accelerate the rate of down-cutting; it was not expressed in any topographic feature of the valleys.

The attempt will not be made to carry the history of the development of the Mississippi drainage beyond the point which has now been reached. The interesting and complicated effects of the ice invasion, which must be considered as but an accident in the Tertiary cycle of development, if touched on at all would form so large a chapter that they cannot be embraced in the present discussion.

THE CORRECT SUCCESSION OF THE OZARK SERIES.

By G. C. Broadhead, State University, Columbia, Mo.

The various members of the Ozark series, as described, defined and numbered in the early geological reports of Missouri, by Swallow, Shumard and others, have been referred to frequently since by others, and the harmony and correctness of the earlier geologists have been acquiesced in by the later workers. In July, 1891, the writer defined and briefly described "The Ozark Series." I have also called attention to the fact, notably in the article just referred to, that the Ozark series seemed, both by fossils and lithologic characters, to be naturally separated from the Silurian above, and should probably be referred to the Cambrian, especially the terranes lying below the first sandstone, and the strata of more

recent age than the porphyries should all be considered as belonging to the age of the Upper Cambrian. The first or Saccharoidal (St. Peters) sandstone, and the first Magnesian limestone may belong to Lower Silurian, but there is not sufficient evidence on the subject.

The recent publication entitled "Iron Ores of Missouri," is interesting, and much of it instructive, especially the discussion of the distribution and nature of the ore deposits, which was the work assigned to the assistant. Thus far the work seems good. The pages treating of the physical geography of the Ozarks are also good.

That part included between pages 93 and 115, and especially that from pages 106 to 115, it would have been much better to have omitted. A competent man should have corrected this and put it in proper form or else it should have been entirely omitted. Now, as these pages reflect upon the accuracy of the work of others, some of whom have passed beyond the Great River, I feel called on to enter a protest. And without reflecting upon any other part of the report I feel that I must correct the false impression that peradventure might enter the minds of others.

On p. 96 Mr. Nason informs us that the reasons of the early geologists for separating the formations by sandstones are insufficient. This seems gratuitous, as he does not give those reasons nor has he sufficiently studied the field to be able to give an opinion. He dwells on the use of the word "recognize." I do not consider that important, for evidently wherever the rocks are recognized they are also identified, but it was not considered necessary to use that word. He quotes from Shumard's report of Franklin, St. Genevieve and Jefferson, and yet from his own writings we would infer that he had not visited those localities. He tries to show that they are incorrect when he himself has not seen the rocks. He just seems to deny the correctness of Shumard's work on general principles. If Mr. Nason made a correct study of the iron ores, he had no time to devote to the geology of such an extensive field as he endeavors to enlighten us upon.

The great Ozark series Prof. Swallow divided into a succession of four limestones, separated by certain sandstones. Each member was fully described and afterwards identified by those that came after. The author of the Iron Ore report makes the statement that the first and second sandstones are one and the same,

(see p. 115). His report is accompanied by a series of numbered sections on Piney river from Cabool to Arlington, and on the Gasconade from Arlington to Gasconade. I am not familiar with the region south of Arlington, but I have followed the Gasconade from the mouth of Little Piney to Gasconade.

Suppose we assume the Missouri bluffs to be a base line. From Washington to Jefferson the series of rocks, in sight along the Missouri Pacific railroad, have been referred by all former geologists of Missouri to the age of the second Magnesian limestone. They consist of a series of siliceous dolomites argillo-magnesian lime-stones, concretionary chert layers and some shale beds with an occasional lenticular bed of white sandstone, in all aggregating over 100 feet in thickness and in some places reaching over 250 feet. One or two thin sandstone layers are here included but the limestones above and below are the well known beds of the second. Such a thin sandstone layer is seen half way up the hill at Chamois and also between Chamois and the Gasconade, likewise in the bluff, at Hermann and a mile east.

The first sandstone is not often seen west of Chamois. East of Chamois it is seen at a few places back on the hills, and at Gasconade it is the highest rock, occurring near the hilltop and probably over 250 feet above the base of the hill. A short distance below the Gasconade are found very large tumbled masses lying near the river. A few miles east it is found banded, pink and white. A mile back of Hermann it is high in the hills, but not at top. At the county line of Gasconade and Franklin it caps the hills, and at this place I obtained fragments of a large species of *Orthoceratite*. All along the railroad the second Magnesian limestone is the lower rock, generally rising over 200 feet in the bluffs. At Gray's summit the Pacific railroad cuts through the first sandstone, as it also does east of Pacific. Our section at Pacific would show:

1st—Trenton limestone.
2d—Black River beds.
3d—First Magnesian limestone.
4th—100 feet of Saccharoidal sandstone.

North of this, on the Missouri bluffs the first sandstone is well exposed. Crossing the Missouri river into St. Charles county, it and its associated rocks both above and below are well exposed. At the county line of St. Charles and Warren the second Magnesian

limestone appears nearly 200 feet in thickness and is capped by the first sandstone.

A section one-half mile east of Augusta shows the following:

1—Beds of Lower Silurian—Black River limestone.
2—94 feet of first Magnesian limestone.
3—5 feet Beds of passage between limestone above and sandstone below, including
  a-1 foot of greenish white calcareous oolite.
  b-1 foot soft yellow sandstone.
  c-1 foot drab oolite, calcareous.
  d-2 feet brown calcareous oolite.
4—130 feet of Saccharoidal sandstone—mostly white.
5—2 feet of chert.
6—Second Magnesian limestone, with some chert and some beds of "cotton" rock.

The beds of passage (No. 3) are also found at several places in Warren and Montgomery counties. On Charette creek in Warren county we find:

1—25 feet of Lower Silurian—Black River beds.
2—59 feet of first Magnesian limestone.
3—70 feet of Saccharoidal sandstone.
4—22 feet of second Magnesian limestone.

Westwardly in Warren' county the sandstone becomes thinner, becoming still less in Montgomery and occurring mostly in pockets farther west resting in eroded valleys of the second Magnesian limestone. On Loutre creek, near the mouth of Whetstone, the upper portion consists of about 3 feet presenting a columnar appearance perpendicular to the bedding plane very much resembling the sides of a piece of ice while melting.

I have examined the Missouri bluffs at most of the outcrops of these on both sides of the river from St. Charles county to beyond Jefferson City and am satisfied with the correctness of my conclusions concerning them. The first sandstone is always soft and generally of a white color and remarkably pure, in silica generally over 99 per cent. At Crystal City, in Jefferson county, we find exposed 75 feet of this sandstone of a white color and soft consistency, and overlying it is the first Magnesian limestone. Nearly 200 miles north and at West Point, Illinois, the first sandstone lies along the river for a mile or more with about 75 feet thickness exposed, while overlying it is the first Magnesian limestone with scarcely any trace of fossils, and also about 75 feet thick. Up stream a quarter of a mile the Black River limestone beds overlie the Magnesian limestone with Trenton limestone still higher containing typical fossils.

Prof. Worthen in the Illinois report speaks of this sandstone as the St. Peter's. Its position here and at other places just named is the same with reference to adjacent beds and it is also white and friable. I have also seen it occupying the same position and presenting the same characters at St. Paul, Minnesota, where it is known as the St. Peter's sandstone.

During their work, the members of the first geological survey of Missouri were taught to be careful and to observe closely, to note every character pertaining to a bed or a formation. It was a school in which to make good stratigraphic geologists. We were directed to note every feature—to collect every fossil, and where fossils were wanting to correlate as nearly as possible, to follow a known stratum or bed and correlate it as we would pass along. Constant practice of this kind made good workers, and in time made rapid workers. We did not wait for some other man to note different features, one man to collect a rock, another a fossil, another a mineral, another to measure, but each man felt it incumbent to do that work himself. In that, and no other way can a man become a good stratigraphical geologist. The student of Archaean rocks often has not so much to guide him, yet he may find the older and newer rocks. In our work we noted all characters and found some fossils. The fossils of course are the most important aids.

In the well at the insane asylum the material was brought up in a pounded condition, and although the divisions of strata could not be so sharply defined as in the cores brought up by a diamond drill, still it was possible to identify strata. In this study one of my keys was the white sandstone at about 1,400 feet from the surface, and it was easily recognized, for its character was similar and the thickness was 133 feet just the same as measured at the outcrop near Augusta 35 miles distant. The overlying materials also approximately agreed in character and thickness. So the identification was satisfactory. The well penetrated the palæozoic rocks 3,843 feet, beginning in Lower Coal Measures and reaching probably to granite. The lower beds were of coarse brown sandstone.

The Second Sandstone.

Near the mouth of the Osage we have over 150 feet of second Magnesian limestone which includes a few thin layers of white sandstone. On the Osage at the mouth of Lake Branch the second

sandstone is seen. A little farther up stream it rises in the hills and the third Magnesian limestone appears below. As we pass up stream the rocks rise to the south and at the mouth of Proffit's creek the second sandstone is on the hilltop with the third Magnesian limestone below. The second sandstone is also found on Maries creek a mile from its mouth and is always a coarse grained rock, coarser than the first and never so white; it is often a buff color with white specks sometimes ferruginous, and many iron ore beds of south Missouri are associated with it, as at the Meremec Iron works. It is the highest rock on the bluffs near Arlington where it rests on the third Magnesian limestone 180 feet above the valley.

Some of Mr. Nason's sections on the Gasconade in the Iron Ore report agree with mine, but he has failed to note the rocks at Mount Sterling, 20 miles south of Missouri river where we find that the third Magnesian limestone has dipped below the surface and soon the second sandstone also disappears dipping northwardly. At Fredericksburgh, ten miles south of Missouri river, the first sandstone appears, and at the mouth of the Gasconade it occupies the hilltop with over 250 feet of second Magnesian limestone below. The first and second sandstones are geologically everywhere over 250 feet apart. Yet in this report (p. 112) they are considered to be the same!! That on the hilltop at Arlington is the second sandstone and it continues to occupy the same position along the Gasconade river in Maries county and nearly half way through Osage.

THE THIRD MAGNESIAN limestone is found in the bluffs below the second sandstone and cannot be confounded with the second Magnesian. It occurs in much thicker beds, sometimes as much as 20 feet and they are often (especially the thicker beds) of a delicate flesh color. The upper beds are often coarse and of a gray color. Chert beds occur but not so often are they accompanied with shale as are those of the second Magesian limestone. Thick beds of limestone do occur near the base of the second Magnesian.

In sections opposite page 106 of Mr. Nason's report we find a thin bed marked "fossils" in nearly all of his sections up to No. 26, but *strange to say* it is omitted in 26,30 and 32, and in his written report he says nothing about fossils in those sections; yet in a subsequent article in the AMERICAN GEOLOGIST he makes the statement that fossils are found in a stratum that has been followed all

along the Gasconade river below the sandstone. I have elsewhere stated that fossils do occur in cherty layers below the second sandstone. That is the position in which he found the fossils up to his Sec. 25. Now, he does not mention having found fossils in Nos. 26 and 30 and I suppose that they were not found. In his published report he says nothing of fossils at Gasconade in No. 32. But in his article in the AMERICAN GEOLOGIST he does make such a statement. Now, I do not doubt that he or someone else may have found fossils at Gasconade, but the layer in which they were found was one much higher geologically and belonging in beds referred to the second Magnesian limestone. There are similar strata with fossils both in the second and third Magnesian limestone formations. The statement made that those near Arlington and Gasconade are identically the same he could not prove unless the connection was uninterrupted. From his own printed sections there must certainly be breaks of at least ten miles.

The first and second sandstones occur in regular beds, often thick. Other sandstones which are thinner and are often lenticular do occur interstratified with the Magnesian limestones as stated elsewhere.

In that part of Missouri lying west of a line passing south from Cole county, the first sandstone is not often found, except in pockets, and the first Magnesian limestone is also seen at but few places. In Cole county just over the second sandstone we find a cellular siliceous rock, very much resembling a buhr stone. This has also been observed in Webster county.

In southeast Missouri, chert beds are generally associated with the second sandstone, and they are often fossiliferous, as in Iron, Madison and Reynolds. These chert beds sometimes are over 100 feet thick.

On page 111 of the iron report, certain fossils are enumerated with Dr. Shumard referred to as authority, and he is made to report the occurrence in the first sandstone of certain fossils in the counties of Wright, Ozark, Miller and Pulaski.* Now, referring to Dr. Shumard's report on Pulaski, Shumard says, "that gasteropods are found in the third Magnesian limestone," and says nothing about them in the sandstone. In the report on Wright county, Dr. Shumard mentions fossils only from the second Magnesian limestone, and says nothing at all about fossils from the

*See Mo. Geological Report, 1855–71.

first sandstone. In his report on Miller county Mr. Meek mentions finding a few casts of fossils, including *Euomphalus* and other Gasteropoda, in chert beds and sandy layers of the second sandstone but names none from the first sandstone, nor does Shumard anywhere say anything about fossils from Miller county, as stated by Mr. Nason.

On page 111 we are informed that Shumard had obtained or reported an *Orthoceratite* from Maries county, with *Straparallus* and *Chemnitzia* from Ozark county and the pygidium of an *Arionellus* from Wright county; the author of the iron report says that Shumard affirms that these are from the first sandstone. Referring to the geological report of 1855-1871, p. 10, we find that Broadhead and not Shumard (as Nason says) found what seemed to be the fragment of an *Orthoceratite* in Maries county. In Shumard's report of Ozark county (Rep. 1855-71), Dr. Shumard states that a few internal casts of *Straparollus* and *Chemnitzia* are found, but were too imperfect for accurate determination. In the same report Shumard mentions other fossils found in the second Magnesian limestone, and also states that he found fossils in the second sandstone and the third Magnesian limestone.

Some fossils found in the second Magnesian limestone also are found in lower series, as *Straparollus*, *Murchisonia*, *Chemnitzia*. Dr. Shumard was too good a geologist and palæontologist to make serious mistakes. He was thoroughly acquainted with the whole Ozark series. A specialist in a certain line, as a mining engineer, may be an excellent expert, but he cannot easily trace out the connection and sequence of beds.

In the interior portion of south Missouri the Ozarks are pushed up, forming the flattened dome of the Ozark plateau and the surface strata are of the Ozark series. Within twenty miles of the Missouri the strata are found dipping northwardly. On the Missouri river bluffs, from the Osage to the east part of Franklin county, the strata along the south side of the river are all of Cambrian age. We do indeed find a few residual fragments of Lower Carboniferous chert and fossils but no Silurian or Devonian. On the north side of the river the Ozark series is overlaid by Lower Silurian all the way from St. Charles county to Callaway. Within ten miles north the Silurian is concealed by the overlying Lower Carboniferous, which is the surface rock, and the ridge dividing the waters flowing into the Missouri from those flowing into the

Mississippi is not so high by 100 to 200 feet as the Ozarks are twenty miles south of the Missouri. Mr. Nason's section at the mouth of the Gasconade shows that the bluffs there are 150 feet higher than the dividing ridge near Montgomery City, and the country near Arlington and Rolla is as much as 300 feet higher. At Arlington the rocks belong to the Ozark series. At Jonesburgh to the Lower Carboniferous.

ON A NATURAL FORMATION OF PELLETS.

By J. A. UDDEN, Rock Island, Ill.

In McPherson county, Kansas, there are several outcrops of a stratum of volcanic dust occurring in presumably Pleistocene beds. (See *Megalonyx Beds in Kansas*, AMERICAN GEOLOGIST, Vol. VII, p. 340). At the time this material fell, it settled in water on the bottom of a lake or of a wide river, which here occupied a depression running north and south. In one of the places where the dust is now exposed, it is seen to have fallen among sedges, or similar growths, in shallow water, and it was agitated by the waves, as it settled, thus becoming decidedly ripple-bedded. At this place there are to be seen imbedded, scattered in the deposit, a number of round white pellets. I purpose to describe these little structures, and to suggest an explanation of their formation.

The deposit here is about five feet in thickness. The lower part of it is penetrated by hollow casts of sedges, which extend from one to two feet upwards from the bottom. Above this the deposit is ripple-bedded for at least two feet, but uppermost this bedding grows indistinct. The pellets are found in greatest abundance in the ripple-bedded horizon and none have been seen in the lower part of the dust. They are mostly lodged in the thickest layers. (Fig. 1.)

The pellets are spherical or lenticular bodies, ranging in size from one to five millimeters in diameter.* They are composed of

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*In 32 specimens taken promiscuously, the different sizes are represented as follows:

Between	.5	mm	and	1	mm	in diameter,		1	specimen.
"	1	"	"	1.5	"	"	"	5	"
"	1.5	"	"	2	"	"	"	9	"
"	2	"	"	2.5	"	"	"	8	"
"	2.5	"	"	3	"	"	"	6	"
"	3	"	"	3.5	"	"	"	2	"
"	3.5	"	"	4	"	"	"	0	"
"	4	"	"	4.5	"	"	"	1	"

the same material as that of the matrix in which they are lodged. Breaking them open they are seen to have an outer dense crust and a loose, porous interior. (Fig. 2.) The thickness of the crust av-

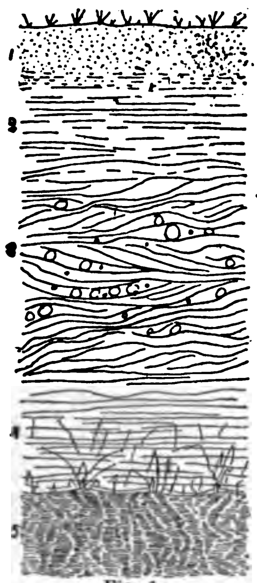

Fig. 1.

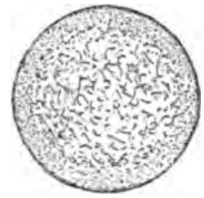

Fig. 2.

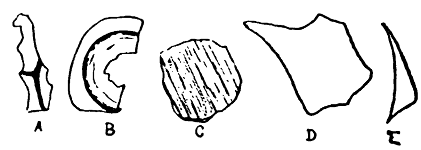

Fig. 3.

Fig. 1. Exposure of the volcanic dust near the N. E. corner of Sec. 14, T. 18 S., R. 3 W., McPherson county, Kansas. 1, Soil; 2, Indistinctly ripple-bedded upper part of the deposit of dust; 3, Ripple-bedded, with pellets; 4, Not ripple-bedded, and with casts of the leaves and stems of sedges; 5, Fine, jointed clay.

Fig. 2. A pellet.

Fig. 3. Flakes of volcanic dust. A, Flake with a branching rib on one side; B, Broken hollow sphere of volcanic glass, with a vertical plate (rib) on the outside; C, Fragment with cavities drawn out into fine tubes; D and E, Plain fragments of broken spheres.

erages in thirty specimens about one-seventh of the total diameter, but it varies from one-fifth to one-seventeenth of the same. As a rule it is uniform all around, but occasionally it is thicker on one side when the outer surface appears to bulge out. Examined under the microscope it is seen to consist of pumice fragments of only the most minute size. A gradual change from the very finest material in the outer part of the crust to larger fragments on the inner side, can always be noticed. Occasionally the entire crust will separate into two or more concentric laminæ.

The interior of the pellets is filled with particles of large size, averaging considerably above that of the dust in which the pellets are imbedded, and loosely placed in the cavity of the crust without any particular arrangement. They do not quite fill the space within the crust. In some cases unbroken hollow spheres of volcanic

glass were found in this interior, and hemispherical and concave fragments are not uncommon (Fig. 3, B). Very likely intact spheres were broken when the pellets were opened, for the material is exceedingly brittle.

The pellets give a peculiar and striking aspect to the rock, where they occur. The question promptly suggests itself; how were they formed? Being found only in that part of the deposit, which is thoroughly ripple-bedded, it is near at hand to inquire, if wave motion may not have produced them. Examining a sand-beach where the wind is throwing the waves against the shore, it may be noticed that the differential motion back and forth in the water close to the bottom, often rolls and *turns over* sand grains resting on the bottom. This rolling motion may be seen still better, if some lighter objects, such as small berries or seeds, or some soaked saw-dust, be thrown into the water. The wave current back and forth is quite noticeable half an inch above the bottom, but the water in immediate contact with the bottom is held by friction and is but very little affected by the motion. An object resting on the bottom will have its lower side held by this comparatively inert layer in the water as well as by the friction against the bottom, while the upper part will be exposed to the impinging force of the current just above. When the force of this current is strong enough, the object will turn over and roll.

It seems that in water holding a great deal of sediment, an object thus set rolling, might gather up around itself minute particles adhering to it. Especially would this be the case, if the object has a rough surface. Such agglomerations would eventually become buried in the sediments, where they formed.

The reader will remember that this volcanic dust is composed of thin flakes, which are the fragments of hollow glass spheres, formed by the expansion of gases in the magma thrown out by a volcanic eruption. The flakes (Fig. 3) are very irregular in shape. Some of the original small hollow glass globes are still entire and may be separated from the rest of the dust by throwing it into water. The broken flakes will then sink, but the little entire spheres will float. When the dust fell a number of the entire hollow spheres no doubt floated on the water for some time, as they will do yet. The angular character of some of the glassy fragments must have caused them to become entangled with such floating spheres and thus to sink them. Most such clusters would

remain where they fell, but some may have had just the right lightness and the right shape to be rolled over the bottom by the currents in the water. Filamentous algæ and other organic bodies may have helped to form them. Once started, such a cluster would pick up fragments that happened to lodge in the interstices among its particles, first larger ones and then smaller. Thus the pellet would grow and form a crust of finer material than that in the nucleus.

If such is the correct explanation of the formation of these structures, similar ones may be looked for in other places, where there is evidence of wave motion and of rapid sedimentation (for it seems that both of these are requisite conditions), whenever the material is of such a nature that its particles are apt to get tangled up with each other. Thin flakes are evidently more apt to form clusters in this way than rounded grains of sand. It may be of interest to mention in this connection that pellets, apparently of a like kind, have been found in ripple-bedded places in the micaceous shales, or sandstones, which make the famous fossil-bearing beds on Mazon creek, in Grundy county, Illinois.

Augustana College, Rock Island, Ills., Jan. 28, 1893.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

A preliminary report on the Coal Deposits of Missouri. By ARTHUR WINSLOW, State Geologist. Geological Survey of Missouri, Jefferson City, November, 1891; 226 pages.—This is the first of a series of subject reports published by the Missouri survey; two others, one on Iron Ores, and another on Mineral Waters, have already been issued.* The report is written in a semi-popular style, but is nevertheless of scientific interest and importance. It is intended, primarily, as a statement, which shall be easily accessible, of what is at present known concerning the coal deposits of the state. The questions of the correlation of the different coal beds and a general discussion of the stratigraphy of the Coal Measures are necessarily but briefly touched upon, or omitted.

That part of the report which is of special interest to the citizens of Missouri is "A systematic description of the coal beds now operated." This occupies more than one-half the report, and brings together a large amount of detail concerning the different pits in workable beds of coal. One of the special features of this part is the large number of detailed sections of the strata immediately above and below the coal

*Reviewed in the last GEOLOGIST.

seams. Many of these sections are accompanied by illustrations showing the relative position and thickness of the different layers and especially of the coal beds.

The first fifty pages contain that which is of most interest to the geologist outside of the state. Within these pages are briefly discussed the distribution, topography, lithology, stratigraphy, and process of deposition of the Coal Measures. Speaking broadly, that part of the state lying to the northwest of a line drawn from the extreme northeastern to the southwestern corner of the state is underlain by Coal Measure strata. Along this line these strata thin out and disappear, but they increase in thickness away from it, reaching a maximum of about 2,000 feet at the northwestern corner of the state. The dip is in the same direction but is slight, being only about ten feet to the mile. The Lower Carboniferous rocks immediately underlie the Coal Measures and the two formations are separated, at least at the margin of the latter, by an erosion interval. The coal beds are more abundant and thickest over the marginal portion of the Coal Measures, but are found throughout the interior.

Under the title, "The process of deposition," a very ingenious and satisfactory hypothesis is outlined. Starting from the following conditions,—that the marginal conditions were generally those favorable to the formation of coal beds, that marine and deep water conditions were more frequent over the central area and that the strata from the base to the top were, at intervals, near the surface,—which are found to be necessary for any interpretation of the process of deposition, Mr. Winslow clearly presents the succession of events which explain the deposition. He begins with discarding the prevalent ideas that the Coal Measures are strictly divisible into a lower, middle and upper series, that there must have been a subsidence over the entire area of some 2,000 feet during the time of accumulation, and that a slight tilting and an enormous amount of erosion must have taken place to bring the strata into their present position. He suggests that when any area is submerged deposition goes on fastest at the margin, but the deposits here are not as thick as those in the interior provided time is allowed for all of the submerged area to be filled in. The margin is the first to become a shallow water area suitable for the accumulation of coal, and as the outer portion was gradually filled with sediments the coal swamp would slowly creep outwards until it covered the whole in a continuous sheet,—provided deposition was continued and subsidence arrested. The result is that the coal bed would be thicker near the margin where the time of accumulation was longer. A later subsidence of the central area, but of small amount, or none at all, at the margin, would make the following sediments slightly unconformable upon the earlier ones; and when shallow water conditions were reached coal would again form and the later coal bed would be nearer the lower one at the margin of the submerged area—actually a part of it were there no marginal subsidence—than towards the interior. In such a manner, with successive periods of subsidence and accumulation,—the subsidence always being

greater in the interior of the basin,—the Coal Measures were deposited. A rapid, continuous, or a frequently recurring subsidence would prevent the accumulation of coal, or would limit its formation to narrow marginal areas. A few simple diagrams make the process of deposition and the relations between the different strata easily understood. A study of the hypothesis presented shows how a moderate amount of erosion will suffice to produce the present limitations of the upper strata; how coal beds are more abundant over the marginal area; how the interval between any two strata may be very different at different points; that a columnar section constructed from outcrop measurements of successively exposed strata from margin to topmost layer will not represent the succession of strata in the interior; that a coal bed may, at one point, immediately overlie strata which are widely separated at another point; that the strata at the margin are not necessarily the lowest; that sandstone, shale or limestone may be prevalent according as the beds were marginal, shallow water or marine portions of the deposit.

The Missouri survey is to be congratulated upon the production of such a neat and handy volume, also upon its subject matter and arrangement, as well as its typography. It is certainly one of the best appearing reports yet issued by a state survey.

The Journal of Geology, is a new publication, "A Semi-quarterly Magazine of Geology and related Sciences," whose editors are T. C. Chamberlin, R. D. Salisbury, J. P. Iddings, R. A. F. Penrose, C. R. Van Hise, C. D. Walcott and W. H. Holmes, with a number of associate editors, some of them being European. It is issued under the auspices and guarantee of the Chicago University. Its purpose is to discuss some of the broad and deep problems of the science of geology—systematic, philosophical, fundamental geology—in its inter-state and international relations. The first number contains:

On the pre-Cambrian rocks of the British isles, Arch. Geikie; Are there traces of man in the Trenton gravels? W. H. Holmes; Geology as a part of a college curriculum, H. S. Williams; The nature of the englacial drift of the Mississippi basin, T. C. Chamberlin; with editorials and reviews.

Phases in the metamorphism of the schists of southern Berkshire, by *William H. Hobbs*. Bull. G. S. A., Vol. IV, pp. 167-178, Feb. 27, 1893. Certain so-called porphyritic minerals occurring in the crystalline schists of southwestern Berkshire county, Massachusetts, and northwestern Litchfield county, Connecticut, are described in this paper. These minerals are feldspar (an acid plagioclase), garnet, staurolite, tourmaline, biotite and ottrelite. Secondary enlargements of feldspar, garnet and tourmaline are discussed and figured. Those of feldspar are the most interesting; here the enlargements are generally of a more basic character than the cores, as is shown by the extinction angle. In cases of feldspar twins the enlargement is sometimes twinned in the same manner as the original grain, and again the enlargement is untwinned. Granophyric

intergrowths of quartz and feldspar occur and these are supposed to be of secondary origin, as has been shown by Irving and Romberg to be sometimes the case. The author concludes that the above mentioned minerals of a porphyritic nature have been developed in an originally clastic rock as the result of orographic disturbance. Internal mechanical movement seems to have had little to do with their formation. "The development of the porphyritic constituents seems therefore to be due to a partial recrystallization of the rock as a result of what I would call *static metamorphism—i. e.*, metamorphism in which pressure is the important factor, in contrast to internal movement, though heat and a mineralizer were important adjuncts."

Zur Genauen Kenntnis der Phonolithe des Hegaus. Von H. P. CUSHING und E. WEINSCHENCK, in Munchen. Phonolites and phonolite tuffs from Hohenttwiel, Gonnersbohl, Staufen, Hohenkrähen, Schwindel, Mägdeberg, Duchtlinger Wald, Plören and Rosenegg, in their petrographical relations form the subject of this paper. The territory is a small one, making noteworthy the very variable character of the phonolites occurring therein. The different types found occurring were nosean phonolite, noseanophyre, leucite phonolite, nephelite phonolite and trachytic phonolite. The nosean phonolite is characterized by porphyritic sanidine, hauyne and augite in a groundmass of sanidine, aegerite and nosean, with nephelite either absent or present in only small quantity. The noseanophyre from Mägdeberg and Schwindel is noteworthy from the much less prominent porphyritic structure. Sanidine, occasional hauynes, and still rarer augites are the minerals of the first generation. In the groundmass in addition to sanidine, aegerite and nosean, nephelite appears in its characteristic four or six sided sections as a characteristic constituent. On the small hill of Staufen two extremely different phonolites occur, true leucite phonolite, and an ordinary nephelite phonolite. In both porphyritic crystals of sanidine, hauyne and augite are of only occasional occurrence, and in both nosean does not appear in the groundmass. The first is characterized by abundance of small leucite crystals and non-appearance of nephelite; in the second no trace of leucite is found and nephelite is abundant. Finally from Gonnersbohl a last well-marked type is found marked off from the rest by the non-appearance of either leucite, nosean or nephelite in the groundmass, which has a trachytic structure; the needle shaped sanidine crystals show well marked flow structure, and between these the arrangement of the zeolite crystals makes it very probable that they arose from an original glassy base. In all these rocks apatite is abundant, titanite common and zircon occasional. Interesting is the occurrence of hauyne minerals in two generations, which Rosenbusch says does not happen.* Micro-chemical tests, wherever these minerals were fresh, showed that the porphyritic crystals were hauyne, those in the groundmass nosean. The latter were locally colored a beautiful deep blue, and this color is easily produced where not present, by simple

*Rosenbusch, Mikroscopische Physiographie der massigen Gesteine, Stuttgart, 1887, p. 614.

heating. The hauyne on the other hand was never blue, and could not be colored artificially either by heating in air, or in sulphur vapor. This is interesting as showing again the uncertainty of attempting to separate hauyne and nosean by the presence or absence of a blue color.

The porphyritic augite also presents features of interest. It agrees closely with the "augite vert" of Michel-Lévy and Lacroix,* and lies between ordinary augite and aegerite in character. Optically $\mathfrak{a}=a$, $\mathfrak{b}=b$, $\mathfrak{c}=c.$, and the extinction angle is never more than 30°. It has a strong pleochroism, $\mathfrak{a}$ being greenish yellow, $\mathfrak{b}$ green, and $\mathfrak{c}$ green with a tinge of yellow. Its crystal form is that of ordinary augite. The pyroxene in the groundmass seems to be always aegerite.

Ursus ferox from Malta.—Geological Magazine [3] X, pp. 67-69. In excavating in parts of the Har Dalam cavern in the Pleistocene of Malta, Mr. JOHN N. COOK, F. G. S., unearthed the entire remains of *Ursus ferox* with canine and molar teeth *in situ* and a number of detached teeth of other individuals of the same species. Large quantities of bones of *Hippopotamus pentlandi*, *Cervus barbarus*, *Elephas mnaidriensis*, and other animals were also discovered. The entire amount of earth excavated amounted to about 720 cubic feet. *Cervus* occurred in a friable marly loam, with a few pebbles, together with fragments of old pottery. Underneath this loam was a layer of indurated, light grey loam (also containing *Cervus*) in which were imbedded *Ursus ferox* and *Hippopotamus pentlandi*. Below this section was another about one and a half feet thick, in which were found numerous remains of Hippopotamus.

From their similar state of preservation the author concludes that these animals occupied the Maltese era contemporaneously.

On a new Fossil Amber-like Resin from Burma; by DR. OTTO HELM, of Danzig. (Records of Geol. Sur. India, vol. xxv, p. 180.) From a preliminary chemical and physical examination upon a small quantity of material the author concludes that this is an entirely new variety of amber. The resin resembles the Baltic succinite, in that it is easy to cut, saw and polish. Hardness, 2.5-3. Sp. Gr., 1,034. Exhibits a fine blue fluorescence.

On Palæosaccus dawsoni, gen. et sp. nov. Hinde. Dr. Hinde in the Geological Magazine [3], x. Feb., pp. 56-59 announces and describes this new hexactinellid sponge, which was discovered by Sir William Dawson, in the Quebec group at Little Métis, Canada. PALÆOSACCUS is cylindrical or sack-like, with thin walls of rhombic meshes, which are large. The strands of the mesh-work consist of fascicles of slender rods, cruciform, and perhaps five-rayed spicules; the inter spaces are either open or covered with a thin layer of irregularly disposed rods and cruciform spicules. No anchoring spicules have been found in immediate connection with the sponge, but there are in the same beds elongated anchoring spicules with ornamental spiral ridges which may perhaps belong to it.

The species is named after its discoverer.

*Michel Levy and Lacroix, Tableaux des minéraux des roches. Paris, 1889.

A Hyena and other Carnivora from Texas. (Proc. Acad. Nat. Sci., III, 1892, p. 326.) Prof. Cope announces a new genus from the Blanco beds (Pliocene) of Texas, which he has named *Barophagus*, and the species *diversidens*, which he concludes was "the scavenger of the Blanco Fauna;" also a new genus and species of a weasel, which he names *Canimartes cumminsii*. *Canimartes* is allied to *Mustela;* also he announces a new cat provisionally referred to *Felis hillianus*, about the size of the Cheetah, with feet shorter than any of the modern cats.

CORRESPONDENCE.

THE MOVEMENT OF MUIR GLACIER.—In the December number of the GEOLOGIST appears the following statement by Prof. G. F. Wright: "In accounting for the *apparent* discrepancy [italics mine] between professor Reid's measurements of the movement of Muir Glacier and my own, in your notice of his important work, attention should have been called to one other point, namely, that we did not measure the same portions of the glacier. Professor Reid measured the motion only so far out from the center as he could plant stakes; but there was a quarter of a mile or more in the middle which he found it impossible to reach. The reason why he could not reach it was that that was the most rapidly moving part where, consequently, the crevasses were impassable."

This statement is based on a misapprehension, does not correspond with the facts, and hence calls for comment. Professor Wright has evidently misread Prof. Reid's statement of the case, and consequently magnifies the importance of that portion of the glacier that Reid's party did not cross. Professor Wright's remarks would lead one unacquainted with the ground to infer that this portion was all that was moving rapidly and was deeply crevassed. He seems himself to share this belief. It is, however, far from being the correct one. He truly says that this part was impassable, and is the most rapidly moving part of the glacier. He fails to realize that the ice adjoining this impassable strip is itself so nearly impassable, that no sharp line of demarkation between that which is impassable and that which is not can be drawn. If professer Reid had not been so experienced at ice work that he was able to guide his party with masterly skill in the face of extraordinary difficulties, at least four of his flags could never have been posted where they were, and thrice as wide a strip of ice would have been regarded as impassable. On several occasions while setting out flags two hours hard work resulted in no greater advance than fifty feet; once, indeed, resulting in a net loss. The difference between ice of that character and ice that is impassable is a microscopic one. The fact is that the swiftly moving, deeply crevassed portion of Muir glacier has a width of fully three-quarters of a mile, and nearly or quite two-thirds of that distance was covered by professor Reid's flags. In this portion the rate of motion in-

creases slowly and gradually from the sides to a point near the center. A glance at professor Reid's map of the ice front, opposite page 55 of his paper in the National Geographical Magazine, will show more clearly than any words the relation which the space not crossed, between his flags Nos. 6 and 7, bears to the space which was crossed. Flags Nos, 5, 6, 7 and 8 are all out in the swiftly moving part of the glacier. Had a flag been planted midway between Nos. 6 and 7 it is a perfectly safe prediction that no motion more rapid than 10 feet a day could have been disclosed. Anything measurably greater than this, moreover, would result in a differential motion whose results on the ice would be almost inconceivable. One must have been out in the midst of that chaos of pinnacles; sharp ridges and yawning crevasses, to fully realize the force of the foregoing statements.

A study of professor Wright's map (Ice Age in N. A., p. 49) will show that his claim that professor Reid and he measured different portions of the glacier, is founded on a misapprehension. Reid names 500 yards as the distance not covered by his flags. Professor Wright's points numbered 2 and 5 cannot both lie in this space, as his figures (given on p. 50, Ice Age in N.A.) show them to be considerably over 3,000 feet apart, and though their direction does not correspond with the line of Reid's flags, their distance as projected on this line would be far more than 500 yards. But he states that point 2 moved 65 feet, point 5, 70 feet a day. One or the other, possibly both of these points, lies in ice in which professor Reid found a motion of 7.2 feet as a maximum.

Further, professor Wright's measurements, taken by themselves, will not bear close scrutiny. He maps a point, No. 4, about midway between Nos. 2 and 5. To this he assigns a motion of 36 feet a day, while points 2 and 5, about equally distant from it to the right and left, are marching forward with a motion double this. Moreover, points 6 and 7, which are much nearer on a line with point 5 than point 4 is, are only moving nine and ten feet respectively. Further, there is no means of telling which one of these points occupies the space which professor Reid's measurements did not cover, or whether any of them do. The directions of motion, as mapped by professor Wright, do not coincide with the directions of the moraines. Muir glacier is retreating, hence it is undoubted that its motion was less rapid in 1890 than in 1886. But it strains the imagination to an unwarrantable extent to ask credence for the proposition that the glacier was moving seven or eight times more rapidly in 1886 than it was in 1890. A decrease of speed of even one-half in that time would be almost beyond belief.

Professor Wright's method of determining the motion was by sighting on pinnacles, which he believed he could recognize from day to day. *It was the only method open to him* with the appliances he had, and with a party numerically so weak. Only a large party, well equipped, and with a leader experienced in climbing over broken ice, can hope to set out flags across Muir glacier. The members of the party of 1890 were unable to distinguish pinnacles from day to day. Even with the flags to help them they considered it unsafe to trust to a pinnacle in order to

determine the motion between the two central flags. The pinnacles themselves change in shape and appearance from day to day with considerable rapidity. Especially is this true during rains, which are often of several days duration. It is believed that they do not furnish a reliable basis of measurement.

The writer holds that the sets of measurements made by professors Wright and Reid are completely discordant, and cannot be made anything else, and that all efforts to show that both may be correct are futile. Should there be any doubt as to which set comes nearest the truth, the final decision must rest with the party which shall measure the motion of Muir glacier for the third time.

Cleveland, O., Feb. 27, '93. H. P. CUSHING.

THE ARTESIAN AND UNDERFLOW INVESTIGATION.—The book reviewed (sic) at page 113 of this volume of the AMERICAN GEOLOGIST, is Part III, of Senate Executive Document No. 41, of the 1st Session of the 52d Congress, which contains the reports of the geologists of "The Artesian and Underflow Investigation," recently made under the direction of the Secretary of Agriculture, on the title page of which my name appears as Chief Geologist. There are in that part of the volume which is properly my own, mistakes of a kind that ordinarily make one gnash one's teeth with vexation on their discovery. The discovery of these came to me at a time when supreme calamity had made me indifferent, and the annoyance is now that such errors (which any man competent to discover them could trace to their source and correct them), are made a stalking horse in the respectable pages of the GEOLOGIST. It seems that the words *Canon Blanco* appear where *Palo Duro* should stand. I had no chance to make a list of errata. In a table of geologic formations, "Tertiary" does not appear to be included in "Cenozoic," nor "Trinity" in "Cretaceous." The removal of a few of the words by the space of two or three *ems* would place the matter right, and any geologist can see it. I saw proof under very adverse circumstances, but did not see the corrections inserted. On such errors the strongest criticisms of the reviewer are made. A misstatement is also made as to the relation of the Brazos river to the Mississippi. Two other rivers are similarly affected by the passage as it stands. The insertion of a single word in one of the sentences referred to would correct the error. I can't prove the word was in the original copy, but any reasonable man with no bad motive would see that its absence was a mere slip. The writer of such a review of course never makes any slips; will he give, therefore, an honest reason why he substituted *underground* for *underflow* in quoting the title of the book he had in hand?

I have said the Palo Duro canon is a thousand feet deep. This would-be critic says it is nine hundred. I used a good barometer, between half past nine and five o'clock, on a quiet day, and returned to the starting point, and the difference of the "out" and "home" trips was less than fifty feet.

My critic says elsewhere:—"Opposite page 37 he gives *Section* XX,

showing a synclinal or trough in which are the outlines of an ideal artesian basin, &c." There is no *Section* XX in my report. There is Fig. XX, and opposite to it on page 37 there are given and numbered five conditions necessary to an artesian flow. The first of these is as follows: (1) "The water bearing stratum must have a continuous dip in one direction, or it may have a synclinal, or double dip to form a trough or basin." After the five conditions my report goes on to say: "These conditions are all shown in Fig. XX." The trough or basin is shown, but "*the continuous dip in one direction*" is more emphatically shown, and the flow of water based upon it. The critic says: "The regular dip from the northwest" is the condition of the Fort Worth-Waco area.

There is really only one point in his review that savors of a criticism of the matter of the report. That is in reference to the geologic section of the Red river Canon. It may be the critic is right, and it may be, also, that in the sixteen months since the report was in preparation there has been some change in my own view about the much battered Jurassic, and that something now in the press will have a bearing on the subject. The matter was, as he admits, *incidental!* The subject of more than one paragraph in my report of which the Red river section is a small part, is the relation of a certain water bearing Tertiary formation to the underlying formations of the plains, one point to be illustrated being that from Nebraska to Texas these subjacent formations are older geologically as we proceed southerly. The illustration would not have been affected if instead of Jurassic I had written Permian, Devonian or Silurian.

The animus of this reviewer is perplexing.

Unfortunately, the edition of the report under notice is exhausted, and many persons will form their estimate of it from reviews. Instead, however, of a "review" showing the scope and character of the work and adding to the information conveyed, by judicious correction or suggestion, this is rather a personal attack on the knowledge and capacity of one of the several authors.

Junction City, Feb. 7, 1893. ROBERT HAY.

REMARKS ON DALL'S COLLECTION OF CONRAD'S WORKS. Upon my return to Washington from a sojourn in Texas I find an article published in the Bulletin of the Philosophical Society of Washington, vol. xii. pp. 215-240, entitled: *Determination of the Dates of Publication of Conrad's "Fossils of the Tertiary Formation and Medial Tertiary," by William Healey Dall.* (*Read before the Philosophical Society, November 12, 1892.*)

In this paper the author has given much interesting information regarding the respective claims of Conrad and Lea for priority in describing the Eocene fossils at Claiborne, Ala. Moreover, the bibliographical notes upon the two works referred to are far more exhaustive, and superior in every way to any heretofore published. A few slight errors, however, have crept into this part of the paper, and since this part has been a special study of mine during odd times for the past two or three years I feel at liberty to suggest the following corrections:

(1.) In the first place "*Fossils of the Tertiary Formation*" [s] is the wording found on the title page of the "*Medial Tertiary*," so that the two titles given by Dr. Dall refer to the same work. Conrad's publication issued in parts from 1832 to 1835 and including mostly Eocene species is entitled, *Fossil Shells of the Tertiary Formations of North America.*

(2.) The color of the covers is not the same for all parts of the first edition of "*Fossil Shells*" &c. (p. 219, line 1.); for example the covers of Nos. 1 and 4 are of a light brownish yellow color and not bright yellow like those of No. 2. The kind of paper used, too, is entirely different. Again the covers of the "reprint" of No. 3 (p. 224) are not grayish green, but deep blue. For this mistake my typewritten copy is at fault. Not having any deep blue paper at hand when this copy was bound, grayish green paper was substituted as a convenient reminder that the covers of this number were totally different from any of the original No's.

(3.) The form of the preface to No. 1, referred to by Dr. Dall as having "been reprinted" (224,) is in fact the original one, while that classified by him as the original (p. 219) is the revised form. This is evident from the fact that good presswork demands that all great headings like *Preface*, *Introduction*, &c. shall occur on right-hand pages. So the Preface referred to evidently does in one of de Gregorio's copies, and it certainly does in E. A. Smith's copy as well as in both copies at the Wagner Institute and in the one at the Philadelphia Academy of Natural Sciences. The preface in these copies begins on page v, and the dedication to Morton is signed, "T. A. Conrad." In the form of the preface cited as the original (p. 219) it commences on page IV, *i. e.* the left hand page of the book and the dedication is signed "T. A. C.;" pp. v and VI have been rewritten and enough extra matter inserted to necessitate intruding on page IV, otherwise the whole book must needs have been repaged. Again, in the original form of the preface (*i. e.* that beginning on p. v.) the following statement occurs: "The organic remains of the Ferruginous Sand formation have already been illustrated by Dr. Morton, who is about to republish his essays, with much additional [illegible]tion and with splendid lithographic figures of shells and z[illegible]." The republication referred to having appeared in 1834, it is e[illegible]t this preface could not have been written subsequent to 1835[illegible]

(4.) In the "republication" of No. 3, Pl. 15 is placed opposi[illegible] 16, opposite page 41; Pl. 17, opposite page 49; Pl. 18, o[illegible] which contains the explanation of all four plates. Pag[illegible] evidently not "misplaced by the printer" as has been [illegible]

(5.) On page 228 occurs the following statement [illegible] forms of the introductory part to the "republicati[illegible] edition, being less obnoxious to criticism by th[illegible] one most commonly found in copies of the w[illegible] have, or could have had access to, seven have [illegible] (viz., Dall's, E. A. Smith's, H[illegible]ard librar[illegible] Clark's, T. H. Aldrich's, and one [illegible]ner [illegible] only have the less "obnoxious" fo[illegible] viz[illegible] tute copy and the Philadelphia Aca[illegible]y [illegible]

The study of the "*Medial Tertiary*" is far less complex than that of the "*Fossil Shells*" &c., owing to the facts that copies of it are much commoner, and the work seems never to have had but one edition in any of its parts except of course the covers. There are, to be sure, several unsettled points relating to this work, but, no one is more capable to deal with them than is Dr. Dall.

Washington, D. C. Feb. 25, 1893. GILBERT D. HARRIS.

GEOLOGICAL SOCIETY OF WASHINGTON.—A Geological Society has recently been organized in Washington, D. C., for the presentation and discussion of topics of interest to geologists. The constitution and standing rules were subscribed to by 109 founders at the first public meeting, March 8th, 1893. Its members are of two classes, active and corresponding. The annual dues of the first are $2.00, and of the second, $1.00. Meetings will be held on the second, and generally also on the fourth Wednesday of each month, from October to May, inclusive.

The journals and bulletins of the various societies appear to furnish sufficient opportunity for the publication of papers read before the society, so that for the present the society will not undertake to publish the papers presented. It will probably issue one bulletin each year containing the address of the retiring president and such other matter as the council directs.

All publications, and if desired, notices of the meetings also, will be sent to corresponding as well as active members.

This circular letter, with the accompanying pamphlet containing the constitution, standing rules, lists of founders and officers of the society, is issued for the information of members and all other persons who are interested in the progress of geological science.

Washington, D. C., March 18, 1893. J. S. DILLER, Secretary.

THE FAUNA OF TUCUMCARI.—In an article in your March number, p. 213, "Remarks on a part of the Review of the Third Texas Report," by Prof. Jules Marcou, I have been quoted as having said "the fauna (meaning that of the Tucumcari region) is an upper Jurassic fauna." This quotation is correct, but as stated by professor Marcou, it was a verbal opinion given in 1889. I do not see why this should be considered of any value, but since it has been twice quoted and is evidently being used in this controversy, it is only proper to state that I do not at present consider myself qualified to give any opinion upon this question. Professor Hill showed me at Ithaca, in the summer of 1891, his superb series of fossils collected in Texas some years before, and demonstrated to my satisfaction that it would be essential for me to study his localities in the field or his collection, and perhaps both of these sources of information, before publishing anything about Tucumcari. I have at present absolutely no opinion about the age of the rocks of this region, the evidence on either side being very conflicting and my information at present far too limited.

Boston, March 16, 1893. ALPHEUS HYATT.

PERSONAL AND SCIENTIFIC NEWS.

THE HAYDEN MEMORIAL MEDAL has been awarded by the committee of the Academy of Natural Sciences, of Philadelphia, to professor Edward Suess, of Vienna.

DIAMONDS IN METEORIC STONES. H. Moissan in the "Comptes Rendus" for 1893, pages 116 and 288, gives the result of his investigation as to the nature of the Canyon Diablo, Arizona, meteorite. He found in it a transparent diamond, black diamond, brown coal, and graphite. In the same periodical, 1893, pages 116 and 288, he mentions the existence of graphite, black diamond and microscopic transparent diamonds in the "blue-clay" of the South African diamond mines, which, he says, contains more than 24 species of minerals. These results are of great interest, especially when taken in connection with the discovery, by W. Luzi and A. Sauer, of graphitoid in certain quartzite slates and phyllytes of the Taxon Erzgebirge. These gentlemen found, near Wiesenthal, an amorphous substance which contained 99.02 per cent. of carbon, and 0.54 per cent. of hydrogen, but no nitrogen. It resembles the mineral schungite, which was discovered in 1884 in phyllyte from the Olonetz government, Russia, and contains some nitrogen. The Canyon Diablo meteorite has also been examined by C. Friedel ("Comptes Rendus," 1893, pages 116 and 290), who found that the microscopic transparent diamonds became visible after removing the black diamonds, or carbonado, with methylene iodide. He found also that between the layers of the nickel-iron and accompanied by lamellæ of schreibersite there were thickish leaves of a lustrous, silver-white substance which proved to be a subsulphide of iron, with 10.2 per cent. sulphur and 88.3 per cent. iron, corresponding, therefore, to formula Fe_5S. Imbedded in this substance were little knots of yellow troilite, and the mixture of ordinary coal, graphite and diamond seemed to be concentrated near the troilite. The little knots of troilite were surrounded by a thin layer of the lustrous subsulphide of iron.

REPRINT OF CONRAD'S TERTIARY FOSSILS. Mr. Gilbert D. Harris, of the Smithsonian Institute, is projecting a reproduction of the Eocene or earlier volume of Conrad's "Tertiary Fossils." The Wagner Free Institute, of Philadelphia, will reprint the Miocene volume, with its engravings and plates, with some new matter, if 150 copies are subscribed for in advance at $3.50 per copy. Mr. Harris' reproduction will consist of Nos. 1, 2, 3 and 4 of the original edition of 1832-33, and the so-called reprint of No. 3, 1835, the various changes being given in full. Mr. Harris will proceed with this when 100 subscriptions have been received at $3.00 each.

INTERGLACIAL PEAT IN WISCONSIN. According to Mr. B. W. Thomas, of Chicago, there is a bed of interglacial peat in the bluffs of Fox river, about one-half mile from the water and forty feet above it, which, on examination, is found to contain fresh water and some marine diatoms. The bed is about four feet thick, with an area of at least four acres. It rests on boulder clay which lies on the St. Peter sandstone, and is overlain by fifteen or twenty feet of the same material, the latter carrying numerous large boulders, some of which are said to show glacial markings. Mr. Thomas says this peat contains several species not found in that recently examined from Minnesota [see 20th Minnesota report], and also lacks some found in Minnesota peat.

THE ILLINOIS WESLEYAN UNIVERSITY, at Bloomington, Illinois, has lately received by bequest from the late George W. Lichtenthaler, a very large conchological collection. It includes also many fossils and minerals, as well as living species of corals, starfishes and other marine species. It was gathered during twenty years, and nearly all parts of the world are represented. It will certainly constitute an attraction for scientists who wish to study any of these forms. It has from twenty-five to fifty thousand specimens, largely named by the best authorities.

THE FIRST OFFICERS OF THE NEW GEOLOGICAL SOCIETY OF WASHINGTON were elected Feb. 25, as follows: *President*, C. D. Wolcott; *Vice Presidents*, S. F. Emmons and W. H. Holmes; *Treasurer*, Arnold Hague; *Secretaries*, Whitman Cross and J. S. Diller; *Council*, G. F. Becker, T. M. Chatard, G. H. Eldridge, G. K. Gilbert and G. P. Merrill. In the list of the names of the "founders" the following are resident outside the District of Columbia: T. C. Chamberlin, R. D. Salisbury and J. P. Iddings, all of the University of Chicago; Ellen Hayes, Wellesley, Mass., and C. R. Van Hise, University of Wisconsin.

A "CIRCULAR OF INFORMATION" HAS BEEN ADDRESSED by Profs. Le Conte and Lawson, of the University of California, representing a larger "joint committee" of the people of that state recommending the proposition to institute a topographical survey of that state. The survey, if undertaken, is to be on the scale of one inch to one mile, or might vary with conditions, and the sheets, for the valley and foot-hill areas of the state, would number 150 or 200. The following specifications were agreed to by the joint committee and the director of the U. S. Geological Survey, and on this basis a proposed law will be brought before the next legislature.

1. That the map be a complete contour topographical map, based upon triangulation and leveling, and constructed by plane-table survey, showing, in addition to the natural features, (1) all existing monuments of township and land grant corners; (2) all railways, canals and public distributing ditches; (3) all public roads, and all other roads in unrestricted use, and therefore virtually public; (4) all county boundaries; (5) all cities, towns, villages, hamlets, prominent mines, and other important

places, with indication of their buildings, together with all isolated dwellings and public buildings outside of town limits.

2. That in each township at least one permanent bench mark be made, with record of the precise altitude above mean sea-level.

3. That all contours be on a scheme involving intervals of five feet, or multiples of five feet, according to the slope of the ground, and that the contour interval be uniformly five feet wherever the slope of the ground is less than fifteen feet to a mile, in which case the contours shall be traced out by actual leveling.

4. That all navigable streams and important water courses be located by continuous survey of their banks.

5. That salt marsh land, and fresh water swamp land, and overflow land be distinguished by distinct conventions, and that the boundaries to be indicated be those of the natural limits, not the legal segregation limits.

6. That there be at least three triangulation points to each plane-table sheet.

7. That the field scale be not less than one and one-third inches to a mile, or three-quarters of a mile to an inch.

8. That the publication scale be one inch to one mile

9. That the size of the atlas sheet be that of a quarter-degree square, limited by the even fifteen minute lines of latitude and longitude.

10. That the U. S. Coast and Geodetic Survey be requested to contribute as many triangulation points as possible.

11. That the headquarters for the survey be in California.

12. That the work be done by the U. S. Geological Survey, under supervision of a commission of five persons representing the State of California, of whom four shall be appointed by the governor, one to be a representative of the agricultural interests of the State, one a representative of the mining interests, one on nomination of the State University, and one on nomination of the Leland Stanford Jr. University; and of whom the fifth commissioner shall be chosen by the others so appointed.

13. That the expense of the survey be divided equally between the State and Federal authorities.

14. That the U. S. Geological Survey engrave the copper-plates for all the map sheets, wholly at its own expense, and that it own the plates, and that the State of California have the right of taking electrotype transfers from each and all of such plates, for its own use.

The preparation of such a map would necessarily be a work of years. Each atlas sheet averaging in cost about $3,000, corresponding in area to about six and one-half townships, would however, in itself be a complete map, independently surveyed, engraved and published. Interruption or termination of the work at any stage, therefore, would not affect the value of what had already been accomplished.

which is indeed of coarsest texture. One-third of the stump had been rotted out with its pithy center before petrification took place. The same must have been the case with some fascicles of cells leaving tubular holes through the length of its growth, some being ⅜ inch in diameter. A still better find was a section of a trunk eight inches long and ten inches thick, from which the perfect characteristics of the tree can be ascertained. From the latter the description and illustration are taken.

ENDOGEN.

Genus: *Winchellina.* (n. gen.).

Winchellina fascina. (n. sp.)

Among the flora of endogens our new genus stands isolated. If no interior arrangement could be ascertained, the exterior only would let us surmise a palm or fern in this form. But the excellent preservation of this plant showing so minutely its inner organization makes it an object of high interest in our fossil flora, as well as in the botanical world. I have named it Winchellina as a token of kind remembrance of the late Dr. Alex. Winchell of Ann Arbor. While we have in numerous plants well developed cell-bundles so arranged as to cause a harmonious cellular promotion and necessarily interwoven with the whole organism, we observe in our plant an arrangement, as it were, of independent growth of fascicles. Each of them being encased by a very thick periderm, exhibits a peculiar inner tissue of oblong sub-quadrate cells with thick walls, simulating a transverse section of Carboniferous fossil pine. The whole tree is composed of such fascicles which are ⅜ inch mean diameter, the outer ones crowding each other in contorted and polygonal forms and causing the longitudinally ribbed exterior. Toward the more inner portion the fascicles become more circular, parenchymous tissue filling the space. The third zone is crowded again with small oval fascicles enclosing tightly the parenchymous center 2½ inches in diameter, the structure of which can be seen in small perfectly circular cells.

It is likely that thiswas a most stately tree and that each fascicle shot out an independent branch crowning the tree with a bundle of diverging long, linear, reed-like branches.

ALASKA.

By JOHN MUIR, Martinez, Cal.

The trip to Alaska from Tacoma through Puget sound and the thousand islands of the Alexander archipelago is perfectly enchanting. Apart from scientific interests, no other excursion that I know of may be made into the wilds of America in which so much fine and grand and novel scenery is unfolded to view. Gazing from the deck of the steamer one is borne smoothly on over the calm blue waters through the midst of a multitude of lovely islands clothed with evergreens. The ordinary discomforts of a sea voyage, so formidable to some travelers, are not felt; for the way lies through a network of sheltered island channels that are about as free from the heaving waves that cause seasickness as rivers are.

Never before the year 1879, when I made my first trip to Alaska, had I been amid scenery so hopelessly beyond description. It is a web of land and water thirty or forty miles wide, and about a thousand miles long, outspread like embroidery along the margin of the continent, made up of an infinite multitude of features, and all so fine and ethereal in tone the best words seem coarse and unavailing. Tracing the shining levels through sound and strait, past forests and waterfalls, between a constant succession of fair azure headlands, it seems as if surely at last you must reach the best paradise of the poets—the land of the blessed.

Some of the channels through which you glide are extremely narrow as compared with the hight of the walls that shut them in. But, however sheer the walls, they are everywhere forested to the water's edge. And almost every individual tree may be seen as they rise above one another—the blue-green, sharply spired, Menzies spruce; the warm yellow-green Merten spruce, with finger-like tops all pointing in one direction, or gracefully drooping; and the airy, feathery, brownish-green Alaska cedar. In such reaches you seem to be tracing some majestic river. The tide currents, the fresh driftwood brought down by avalanches, the inflowing streams, and the luxuriant over-hanging foliage of the shores, making the likeness all the more complete.

But the view changes with magical rapidity. Rounding some bossy cape the steamer turns into a passage hitherto unseen, and glides through into a wide expanse filled with smaller islands

sprinkled wide apart, or clustered in groups such as only Nature could invent. Some are so small and low the trees covering them seem like mere handfuls that have been culled from the larger islands and set in the water to keep them fresh, the outer fringing trees around the sides oftentimes spreading like flowers leaning out against the rim of a vase. Thus thoughtfully beautiful are these blessed islands; and their beauty is the beauty of youth. For though the softness of their verdure must be ascribed to the copious and warm moisture in which they are bathed, from the mild ocean-current that comes from Japan, the Japan current that bathes these shores is itself young, while the very existence of the islands, their main features, finish and peculiar distribution, are directly referable to the structure of the rocks, and the action of ice upon them during the glacial period, now drawing to a close.

The first stop made by the Alaska steamers after touching at Seattle, Port Townsend, Victoria and Nanaimo, is usually at Fort Wrangel, the distance between the last two places being about 600 miles. Wrangel is a boggy place, but is favorably situated as a center for excursions to some of the most interesting portions of the country. Indians may be seen on the platforms of the half dozen stores, chiefly grim women and cubby, chubby children with wild eyes. Most of them have curiosities to sell when a steamer arrives, or a basketful of berries, red, yellow and blue, which look wondrous clean as compared with the people. They are a proud and intelligent race, nevertheless, and maintain an air of self-respect that no amount of frazzled raggedness and squalor can wholly subdue. Many canoes may be seen along the shores, all fashioned alike, with long beak-like sterns and prows. What the mustang is to the Vacquero the canoe is to the Indian of the Alaska coast. Yonder you see a whole family, grandparents and all, making a direct course for some islands five or six miles away. They are going to gather berries, as the baskets show. Nowhere in my travels north or south have I ever seen so many berries. The woods and meadows are full of them—huckleberries of many species, salmonberries, blackberries, currants and gooseberries with strawberries and serviceberries in the drier grounds, and cranberries in the bogs, sufficient for every worm, bird, beast and human being in the territory, and thousands of tons to spare. The Indians beat them into pulp, press the pulp into cakes about an inch thick, and dry them for winter use with their oily salmon. So fruitful is Alaska.

The coast climate is remarkably bland and temperate. It is rainy, however, but the rain is good of its kind; mild in temperature, gentle in its fall, filling the fountains of the streams, and keeping the whole land fresh and fertile. While anything more delightful than the shining weather after the rain—the great round sun-days of June, July and August, can hardly be found elsewhere. Strange as it may appear, many who are looking to Italy for health had better turn their eyes to Alaska. An Alaska mid-summer day is a day without night. In the extreme northern portion of the territory the sun does not set for weeks, and even as far south as Sitka and Wrangel the rosy colors of evening blend with those of the morning, leaving no darkness between. Nevertheless the full day opens slowly. A low arc of colored light steals round to the northeastward with gradual increase of hight and span, the red clouds with yellow dissolving edges subside into hazy dimness, the islands with ruffs of mist about them cast ill-defined shadows and the whole firmanent changes to pale pearl-gray.

As the day advances toward high noon, the sun flood pouring through the damp atmosphere lights the waters and sky to glowing silver. Brightly now play the ripples about the edges of the islands, and over plume-shaped streaks between them where the water is stirred by some passing breeze. On the mountains of the main-land and in the high walled fiords and canons still brighter is the work of the sunshine. The broad white bosoms of the glaciers glow like molten silver, and their crystal fronts and multitude of icebergs are kindled to a blaze of irised light.

You are warmed and awakened into sympathy with all the world. Through the midst of the brooding silence the life and motion about you comes to mind—the weariless tides swaying the dulse over thousands of miles of sea-meadows, the foaming rivers, the swift floods of light through the satiny sky, the marvelous abundance of fishes, the wild sheep and goats on a thousand grassy ridges above the forests, bears feasting in the berry tangles, the beaver and mink and otter far back on many a rushing stream, Indians and adventurers pursuing their lonely ways, the leaves of the forests feasting on the sunbeams, and the glaciers in glorious array fashioning the mountains, extending the domain of the sea, tracing valleys for rivers to flow in, and grinding the rocks to soil for fertile fields for the use of life to come.

Through the afternoon the day grows in beauty. The air seems

to thicken without losing its fineness, and everything settles into deeper repose. Then comes the sunset with its purple and gold, blending earth and sky—everything in the landscape in one inseparable scene of enchantment.

During the winter snow falls on the fountains of the glaciers in astonishing abundance, but lightly on the lowlands of the coast; and the temperature is seldom far below the freezing point. Back in the interior beyond the mountains the winter months are intensely cold, but fur and feathers and fuel abound there.

The bulk of the woods is made up of two species of spruce and a cypress. The most valuable of these as to timber is the yellow cedar, or cypress; a fine tree, 100 to 150 feet high. The wood is pale yellow, durable, and delightfully fragrant. The Menzies spruce, or "Sitka pine," is larger and far more abundant than the first. Perhaps half of the forest trees of southeastern Alaska are of this species. The graceful Merten spruce or hemlock is also very abundant. Alaska has but few pines. The hard woods are birch, maple, alder and wild apple, forming altogether a scarcely appreciable portion of the forests. In the region drained by the Yukon the principal tree is the white spruce. I saw it growing bravely on the banks of rivers that flow into Kotzebue sound, forming there the extreme edge of the Arctic forests.

The underbrush is mostly huckleberry, dogwood, willow, alder, salmonberry vines, and a strange-looking woody plant, about six or eight feet high, with limber rope-like stems, and heads of broad leaves like the crowns of palms. Both the stems and leaves are armed with barbed spines. This is the *Echinopanax horrida*, or devil's club; and it well deserves both its names. It is used by the Indians as an instrument of torture, especially in the work of correcting witches.

The ground is covered with a thick felt of mosses, about as clean and beautiful as the sky. On this yellow carpet no dust ever settles, and in walking over it you make no mark nor sound. It clothes the raw earth, logs, rocks and ice warmly and kindly, stretching untorn to the shores of the Arctic ocean.

The whole country is shining with perennial streams, but none of them, from the mighty Yukon, 2,000 miles long, to the shortest torrent rushing from the coast glaciers, has been fully explored. The Stikeen, one of the best known rivers of the territory, is about 350 miles long, and draws its sources from

the northern part of the broad Rocky Mountain plateau, in company with some of the affluents of the Mackenzie and Yukon. It flows first in a westerly direction, then curving southward enters the Coast range, and sweeps across it in a cañon that is about a hundred miles long, and like Yosemite valley from end to end. To the appreciative tourist sailing up the river the cañon is a gallery crowded with sublime and beautiful pictures, an unbroken series of ice-capped mountains, cliffs, waterfalls, lovely gardens, groves, meadows, etc.; while the glaciers pushing forward through the trees vastly enhance its wildness and glory.

Another interesting excursion may be made from Wrangel to the deserted village of the Stikeens. The moss-grown ruins are picturesque, and surprisingly massive and substantial considered as the work of Indians. Some of the wall planks are two and three feet wide, six inches thick, and forty feet long; while the carved timbers that support the ridge poles, and the strange totem poles, display marvelous specimens of savage art. A few good specimens may also be seen at Wrangel. Similar monuments are made by all the tribes of the archipelago. Those of the Haidahs surpass all others in size and workmanship.

While the Cassiar gold mines were being developed, Wrangel was the most important town in the territory, but Juneau is now the chief mining center. Nearly all the gold of Alaska is still in the ground. Probably not one of a thousand of its veins and placers has been yet touched. The color of gold may be found in almost every stream, and hardy prospectors are seeking their fortunes in every direction. Many have already made their way into the vast region drained by the Yukon, and the developments thus far show that this northern portion of the gold belt of the continent is at least moderately rich, and mining may safely be regarded as one of the chief resources of the territory.

From Wrangel the steamer goes up the coast to the Taku glacier and Juneau. After passing through the picturesque Wrangel narrows you may notice a few icebergs, the first to be seen on the trip. They come from a large glacier at the head of a wild fiord near the mouth of the Stikeen. When I explored it eleven years ago I found difficulty in forcing a way up the front through ten or twelve miles of icebergs. My Indians told me they called this fiord "Hulti," or Thunder bay, from the noise made by the discharge of the ice. This, as far as I know, is the

southmost of the great glaciers of the first class that flow into tide water.

Gliding northward your attention will be turned to the mountains of the Coast range, now for the first time near and in full view. The icy cañons open before you as you pass in regular order showing their wealth. Now a bold headland will hold the eye, or some mountain of surpassing beauty of sculpture, or one of the larger glaciers seen directly in front, its gigantic arms and fingers clasping an entire group of peaks, and its broad, white trunk sweeping down through the woods, its crystal current breaking here and there in shattered cascades, with azure light in the crevasses, making you deplore your inability to stop and enjoy it all in cordial nearness. It was from one of these glaciers to the south of cape Fanshaw that the Alaska Ice company loaded their ships for California and the Sandwich islands.

In a few hours you come in sight of more icebergs. They are derived from four large glaciers that discharge into the heads of the long arms of Holkam bay, or Sum Dum. Never shall I forget the wild adventurous days spent there in the summers of 1879 and 1880.

At the mouth of the Taku inlet you encounter another fleet of drifting icebergs from the grand Taku glacier, twenty miles distant.

On one of my early exploring trips I stopped at an Indian village here and found it deserted. Not a single person was left on guard. For these people are so rich they have little to lose. My Indians said that the inhabitants were away catching and drying salmon. All the Indian villages are thus abandoned at regular periods every summer, while everybody goes to fishing, berrying and hunting-stations, occupying each in succession for a few weeks. Then after the summer's work is done, the winter supply of salmon dried and packed, fish and seal oil stored in boxes, berries and spruce bark beaten and pressed, their hunts after wild goats, sheep and bears, brought to a close, their trading-trips made, and the year's stock of quarrels with the neighboring tribes settled, then, all at home in their big block-houses, they give themselves to pleasure, feasting, dancing, visiting, speech-making, drinking, etc.

The Taku inlet contains many glaciers, one of which belongs to the first-class. It makes a grand display of itself as it comes

down from its lofty fountains into the head of the fiord and sends off its bergs. To see this one glacier is well worth a trip to Alaska. At the time of my first visit, while I sat in my canoe, among the ice, sketching and watching the birth of the bergs as they plunged from the glorious crystal wall, two Indians, father and son, came paddling alongside, and with a good natured "Saghaya" inquired who we were and what we were looking for in such a place, etc., while they in turn gave information about the river, their village and the glaciers up the main Taku cañon. They were hunting seals, and as they shot away crouching in their tiny shell of a canoe, with barbed spear in place among the great blue overhanging bergs, they formed a picture of arctic wildness as telling as may be found amid the drifts and floes of Greenland.

After leaving Juneau, where, it is claimed, you may see "the largest quartz mill in the world," the steamer passes between Douglas and Admiralty islands into Lynn canal, the most sublimely beautiful and spacious of all the mountain-walled channels you have yet seen. The Auk and Eagle glaciers are displayed on the right as you enter the canal, coming with grand effect from their far-reaching fountains and down though the forests. But it is on the west side of the canal near the head that the most striking feature of the landscape is seen—the Davidson glacier. It first appears as an immense ridge of ice thrust forward into the channel, but when you have gained a position directly in front, it is shown as a broad flood issuing from a noble granite gateway, and spreading out to right and left in a beatiful fan-shaped mass, three or four miles in width, the front of which is separated from the water by its terminal moraine. This is one of the most notable of the large glaciers that are in the first stage of decadence, reaching nearly to tide water, but failing to enter it and send off icebergs. Excepting the Taku, all the great glaciers you have yet seen belong to this class.

Shortly after passing the Davidson the northmost point of the trip is reached, and at the canning establishments near the mouth of the Chilcat river you may learn something about salmon. Whatever may be said of other resources of the territory—timber, furs, minerals, etc.—it is hardly possible to exaggerate the importance of the fisheries. Besides cod, herring, halibut and other fishes that swarm over immense areas, there are probably more than a thousand salmon streams in Alaska, in some of

which at certain seasons there is more fish than water. Once I saw one of my men wade into the midst of a crowded run and amuse himself by picking up the salmon and throwing them over his head. On rocky shallows thousands could thus be taken by hand in an hour or two.

The steamer now goes down the canal, through Icy strait, and into the wonderful Glacier bay. All the voyage thus far from Wrangel has been icy, and you have seen hundreds of glaciers great and small. But this bay and the region about it and beyond it towards mount St. Elias is pre-eminently the Iceland of Alaska and the entire Pacific coast.

Glancing for a moment at the results of a general exploration we find that there are between sixty and seventy small residual glaciers in the California sierra. Through Oregon and Washington, glaciers, some of them of considerable size, still exist on the highest volcanic cones of the Cascade mountains—the Three Sisters, mounts Jefferson, Hood, St. Helens, Adams, Tacoma, Baker, and others, though none of them approach the sea. Through British Columbia and southeastern Alaska the broad sustained chain of mountains extending along the coast is generally glacier-bearing. The upper branches of nearly every cañon are occupied by glaciers, which gradually increase in size to the northward until the lofty region between Glacier bay and mount St. Elias is reached. In Prince William sound and Cook's inlet many grand glaciers are found, but farther to the westward, along the Alaska peninsula and the chain of the Aleutian islands, though a considerable number of glaciers occur on the highest peaks, they are quite small and melt far above sea-level, while to the north of latitude 62°, few, if any, remain in existence; the ground being comparatively low, and the snowfall light.

The largest of the glaciers that discharge into Glacier bay is the Muir, and being also the most accessible is the one to which tourists are taken and allowed to go ashore and climb about its ice cliffs and watch the huge blue bergs as with tremendous thundering roar and surge they emerge and plunge from the majestic vertical ice-wall in which the glacier terminates.

The front of the glacier is about three miles wide, but the central berg-producing portion, that stretches across from side to side of the inlet like a huge jagged barrier, is only about half as wide. The hight of the ice-wall above the water is from 250 to

300 feet; but soundings made by captain Carroll show that about 720 feet of the wall is below the surface, while still a third portion is buried beneath moraine material. Therefore, were the water and rocky detritus cleared away, a sheer wall of blue ice would be presented a mile and a half long and more than a thousand feet high.

The number of bergs given off varies somewhat with the tides and weather. For twelve consecutive hours I counted the number discharged that were large enough to be heard like thunder at a distance of a mile or two, and found the rate to be one in five or six minutes. When one of the fissured masses falls there is first a heavy, plunging crash, then a deep, deliberate, long-drawn-out thundering roar, followed by clashing, grating sounds from the agitated bergs set in motion by the new arrival, and the swash of waves along the beach. All the very large bergs rise from the bottom with a still grander commotion, heaving aloft in the air nearly to the top of the wall, with tons of water pouring down their sides, heaving and plunging again and again ere they settle and sail away as blue crystal islands ; free at last, after being held rigid as part of the slow-crawling glacier for centuries. And strange it seems, that ice formed from snow on the mountains two and three hundred years ago, should after all its toil and travel in grinding down and fashioning the face of the landscape still remain so lovely in color and so pure.

The rate of motion of the glacier as determined last summer by Prof. Reid is, near the front, about from five to ten feet per day. This one glacier is made up of about 200 tributary glaciers, which drain an area of about a thousand square miles, and contains more ice than all the eleven hundred glaciers of the Alps combined. The distance from the front back to the head of the farthest tributary is about fifty miles, and the width of the trunk below the confluence of the main tributaries is twenty miles or more.

I made my first visit to Glacier bay toward the end of October, 1879. Winter weather had set in ; young ice was forming in the sheltered inlets, and the mountains had received a fresh covering of snow. It was then unexplored and unknown except to Indians. Vancouver, who surveyed the coast nearly a hundred years ago, missed it altogether, on account, I suppose, of bad weather and a jam of ice across its mouth.

I had spent the best part of the season exploring the cañon of the Stikeen river, and a little of the interior region on the divide of some of the southerly tributaries of the Yukon and Mackenzie. It was getting rather late for new undertakings when I returned to Wrangel, but eagerness to see some of the glaciers to the northward, however imperfectly, drove me on. Assisted by Mr. Young, the enthusiastic Alaska missionary, I succeeded in procuring a canoe and a crew of four Indians—Toyette, Kadechan, Stikeen John, and Sitka Charley. Mr. Young who was anxious to learn something of the numbers and condition of the Indian tribes that might be seen on the way, agreed to go with me. Hastily gathering the necessary supplies, we set forth October 14th. While we were on the west shore of Admiralty island, intending to make a direct course up Lynn canal, we learned that the Chilcat Indians were drinking and fighting, and that it would be unsafe to go among them until their quarrels were settled. I decided therefore to turn westward through Icy strait and go in search of Sitka Charley's wonderful "ice mountains." Charley, who was the youngest of my crew, having noticed my interest in glaciers, told me that when he was a boy he had gone with his father to hunt seals in a large bay full of ice, and he thought that he could find it.

On the 24th, as we approached an island in the middle of Icy strait, Charlie said that we must procure a supply of wood there to carry with us, because beyond this the country was bare of trees. Hitherto we had picked our way by Vancouver's chart, but now it failed us. Guided by Charlie, who alone knew anything of the region, we arrived late in what is now called "Bartlett bay," near the mouth of Glacier bay, where we made a cold camp in rain and snow and darkness. At daylight on the 25th we noticed a smoke, where we found a party of Hoonah seal-hunters huddled together in a small bark hut. Here Sitka Charlie seemed lost. He declared the place had changed so much he hardly recognized it, but I succeeded in hiring one of the hunters to go on with us up the main Glacier bay, or "Sita-da-ka," as the Indians called it. The weather was stormy, cold rain fell fast, and low, dull clouds muffled the mountains, making the strange, treeless land all the more dreary and forbidding. About noon we passed the first of the low descending glaciers on the west side, and found a landing-place a few miles beyond it. While

camp was being made I strolled along the shore, eagerly examining the fossil wood with which it was strewn, and watching for glimpses of the glaciers beneath the watery clouds. Next day the storm continued, a wild southeaster was howling over the icy wilderness, and everybody wished to remain in camp. Therefore I set out alone to see what I might learn. Pushing on through mud and sludgy snow I gained at length a commanding outlook on a bald promontory, about 1,500 feet high. All the landscape was smothered in busy clouds, and I began to fear that I had climbed in vain, when at last the clouds lifted a little, and the ice-filled expanse of the bay, and the feet of the mountains that stand about it, and the imposing fronts of five of the great glaciers, were displayed. This was my first general view of Glacier bay—a stern solitude of ice and snow and raw, newborn rocks, dim, dreary, mysterious

I held my high ground, gained at such cost, for an hour or two, sheltering myself as best I could from the blast, while with benumbed fingers I sketched what I could see of the stormy landscape, and wrote a few lines in my notebook. Then I beat my way back to camp over the snow-smothered ridges and bowlder piles and mud beds, arriving about dark.

Mr. Young told me that the Indians were discouraged and would like to turn back. They feared that I had fallen, or would fall, or in some way the expedition would come to grief in case I persisted in going farther. They had been asking him what possible motive I could have in climbing mountains in such miserable weather; and when he replied that I was seeking knowledge, Toyette remarked that Muir must be a witch to seek knowledge in such a place.

After coffee and hard-tack, while we crouched in the rain around a dull fire of fossil wood, the Indians again talked dolefully, in tones that accorded well with the growling torrents about us and the wind among the rocks and bergs; telling sad stories of crushed canoes, hunters lost in snowstorms, etc. Toyette said that he seemed to be sailing his canoe into a "skookum house" (jail) from which there was no escape, while the Hoonah guide said bluntly that if I was going near the noses of the ice-mountains he would not go with me, for we would all be lost by bergs rising from the bottom, as many of his tribe had been. They seemed to be sinking deeper into dismal dumps

with every howl of the storm, when I reminded them that storms did not last forever; the sun would shine again; that with me they need fear nothing, because good luck followed me always, though for many years I had wandered in higher mountains than these, and in far wilder storms; that Heaven cared for us and guided us all more than we knew, etc. This small speech did good. With smiling reassurance Kadechan said that he liked to travel with fearless people; and dignified Toyette declared he would venture on, for my "wa-wa was delait" (my talk was very good).

We urged our way against ice and weather to the extreme head of the bay and around it, going up one side and down the other and succeeded in reaching all the main glaciers excepting those at the head of frozen inlets.

Next to the Muir, the largest of the glaciers enters the bay at its extreme northwestern extension. Its broad, majestic current, fed by unnumbered tributaries, is divided at the front by an island, and from its long, blue wall the icebergs plunge and roar in one eternal storm, sounding on day and night, winter and summer, and from century to century. Five or six glaciers of the first class discharge into the bay, the number varying as the several outlets of the ice fields are regarded as distinct glaciers, or one. About an equal number of the second class descend with broad imposing currents to the level of the bay without entering it to discharge bergs; while the tributaries of these and the smaller glaciers are innumerable.

The clouds cleared away on the morning of the 27th, and we had glorious views of the ice-rivers pouring down from their spacious fountains on either hand, and of the grand assemblage of mountains immaculate in their robes of new snow, and bathed and transfigured in the most impressively lovely sunrise light I ever beheld. Memorable, too, was the starry splendor of a night spent on the east side of the bay, in front of two large glaciers north of the Muir. Venus seemed half as big as the moon, while the berg-covered bay, glowing and sparkling with responsive light, seemed another sky of equal glory. Shortly after three o'clock in the morning I climbed the dividing ridge between the two glaciers, 2,000 feet above camp, for the sake of the night views; and how great was the enjoyment in the solemn silence between those two radiant skies no words may tell.

That morning we had to break a way for the canoe through a sheet of ice half a mile wide, which had formed during the night. The weather holding clear, we obtained telling views of the vast expanse of the Muir glacier and made many sketches. Then fearing that we might be frozen in for the winter we hurried away back through Icy strait into Lynn canal. We then visited Davidson glacier and the Indian village at the mouth of the Chilcat river, where we obtained views of three other low descending glaciers of the same rank as the Davidson. Thence, turning south, homeward bound, we passed the Auk and Eagle glaciers, and battled awhile with the bergs of Sum Dum, narrowly escaping being frozen among them. North of cape Fanshaw we were stormbound nearly a week ere we could visit the great glacier near the mouth of the Stikeen. November 20th we reached Wrangel, and our ice lessons for the season were done.

Next year in August I again set out from Wrangel in a canoe and made more careful examination of the glaciers in Glacier bay, and of many new ones that I discovered during the season, the most noteworthy being those of Sum Dum and the immense glacier at the head of Taylor bay to the west of Glacier bay, in crossing which I encountered some exciting adventures.

Again last summer I spent two months in Glacier bay, mostly on the Muir glacier getting acquainted with its higher fountains, studying the fossil forests about it and the rich and lovely flora of the lower ridges, etc. Fain would I describe the glories of those months in the ice-world—the beautiful and terrible network of crevasses, the clustering pinnacles, the thousand streams ringing and gurgling in azure channels cut in the living body of the glacier, the glorious radiance of the sunbeams falling on crystal dale and hill, the rosy glow of the dawn and sunset, the march of the clouds on the mountains, and the mysterious splendor of the auroras when the nights grow long, etc., etc., etc. But this would require a volume, while here I have only the space to add—Go to Alaska, go and see.

THE RELATION OF THE CRETACEOUS DEPOSITS OF IOWA TO THE SUBDIVISIONS OF THE CRETACEOUS PROPOSED BY MEEK AND HAYDEN.

By S. CALVIN, Iowa City, Iowa.

The Cretaceous deposits of Woodbury and Plymouth counties are composed of sandstones, shales and certain calcareous deposits. The heavier beds of sandstone belong to the basal portions of the series, barely rising higher than 40 feet above the level of the water in the Big Sioux river. The part of the column to which these heavier sandstones are confined is however not all sandstone, but consists of arenaceous beds alternating with beds of argillaceous shales. Above the more massive sandstones the beds, for a vertical distance of 50 or 60 feet, contain streaks and thin layers of sand, but shales preponderate. In certain typical exposures these alternating beds are followed by from thirty to forty feet of pure shales, dark in color, smooth and unctuous to the feel, and containing the remains of saurians related to *Plesiosaurus*, teleost fishes, and, in the uppermost beds, impressions of *Inoceramus*. At the summit of the column, overtopping shales and sandstones alike, are the calcareous beds to which allusion has been made. These consist in part of soft chalky material and in part of more indurated, though still soft, beds of fissile limestone that divides under the hammer or on exposure to the weather, into relatively thin laminæ crowded with detached valves of *Inoceramus problematicus* Schlot.

In the portion of the section between the massive sandstone and saurian-bearing shale the beds are not everywhere constant. In some places they contain thin bands of ferruginous concretionary sandstone. At Riverside, for example, and at the works of the Sioux Paving Brick Co., there is a mass of rather thin-bedded calciferous sandrock in the upper part of this division developed to a thickness of eighteen feet.

A generalized section of the beds along the bluffs facing the Big Sioux river, omitting some minute details and averaging local peculiarities of certain beds, would be, beginning at the base of the series:

1.	Irregular beds of sandstone, varying in color and texture, and interstratified with thin beds of shale....................	18′
2.	Grayish and mottled shales with thin ferruginous bands and arenaceous layers....................................	12′
3.	Massive sandstone, mostly soft; but in places containing large concretionary masses, several feet in diameter, in appearance and hardness resembling quartzite..............	10′
4.	Shales with usually two, but sometimes more, well marked thin bands of ferruginous concretionary sandstone. ("Buttons" of the clay workers.)............................	16′
5.	Band of impure lignite..............................	4 to 6 inches
6.	Blue, yellow and red mottled clays (terra cotta clays) with selenite crystals and some streaks of sand................	30′
7.	Argillo-calcareous or arenaceo-calcareous beds with much selenite (varying with locality)...........................	20′
8.	Shales more or less unctious to the feel, somewhat variable in color and texture, containing remains of saurians and teleost fishes, the upper beds sometimes bearing impressions of *Inoceramus problematicus*...............................	40′
9.	Calcareous beds consisting of chalk and soft, thin bedded limestone, containing shells of *Inoceramus problematicus*, *Ostrea congesta*, and teeth of *Otodus*, *Ptychodus* and other selachians..	30′

Beds that are quite constant and easily recognizable in the region about the mouth of the Big Sioux river are Nos. 3,4,5,8 and 9. These, either singly or collectively, become the guides whereby the beds of the several exposures may be correlated. The deposits were traced up the Big Sioux valley for a distance of forty miles; they were followed up the Missouri river as far as Yankton.

In addition to the deposits exposed on the Big Sioux, Dr. C. A. White, under the name of the *Nishnabotna sandstone*, refers to the Cretaceous age a series of sandstones developed to a thickness of 100 feet along the river valleys in Montgomery, Cass, Guthrie and Greene counties. Referring to the work done by Meek and Hayden on the Cretaceous deposits exposed along the Missouri river and noting the names employed by these authors to designate the various subdivisions of their "Earlier Cretaceous," Dr. White says: "The Cretaceous strata of Iowa have so slight a development in comparison with those farther up the Missouri river, that it is difficult to determine their stratigraphical equivalents without actual comparison, which it has thus far been impossible to make. There is no doubt, however, that all the Iowa Cretaceous strata belong to the 'Earlier Cretaceous' of Meek and Hayden, nor any doubt that the lowest portions of ours is equivalent to a part of their Dakota group." (White's *Geology of Iowa*, vol. i, p. 288, 1870). Without attempting, therefore, to synchronize the Cretaceous of Iowa with the Cretaceous formations studied by Meek

and Hayden, Dr. White applies to all the strata at Sioux City lying below the chalk the name of *The Woodbury Sandstones and Shales*, while the calcareous deposits composed of chalk and soft Inoceramus-bearing limestone he calls the *Inoceramus beds*.

Below the mouth of Iowa creek, about three miles nearly east of Ponca, Nebraska, the Missouri river washes the foot of a high bluff in which Cretaceous strata, identical in all essential respects with those seen in Iowa above the mouth of the Big Sioux, are exposed to a hight of more than a hundred feet. The several beds of the preceding section, from 2 to 8 inclusive, are easily recognized, and at the summit of the section, cropping out from beneath the thick mantle of loess, are indications of the chalky beds of number 9. Farther up the river, almost directly north of Ponca, there is another splendid natural section which is more than a mile in length and at least 150 feet in hight. At the base of the section are the beds seen below the mouth of Iowa creek, while away above all the sandstones and shales lie from twenty-five to thirty feet of rather hard chalk and *Inoceramus*-bearing limestone. There can be no doubt that the beds near Ponca, Nebraska, are the exact equivalents of beds in Iowa. Indeed one may look away from the exposure at the bend east of Ponca, across the plain which is here the combined valley of the Missouri and Big Sioux, for a distance of only ten or twelve miles to the corresponding exposures in Iowa. In the two bluffs that look toward each other from opposite sides of the plain, you may trace the same succession of strata that, but for the erosion of the two great streams, would still be continuous across the intervening space. Furthermore the beds are about equally well developed on both sides of the valley.

Now the exposure at the bend of the Missouri, three miles below Ponca, Nebraska, is described in detail by Hayden in the *First Annual Report of the United States Geological Survey of the Territories*, 1867, pp. 47 and 48. The chalky, marly or calcareous beds, which are the exact equivalent of the *Inoceramus* beds of Iowa are referred to the *Niobrara* group. The dark colored shale, identical with number 8 of the preceding section is called the Fort Benton Group, while all the complex mass of alternating sandstones and shales in the basal part of the exposure is recognized as belonging to the Dakota group.

Between Ponca and St. James, about thirty miles in a direct

line farther up the Missouri, the chalky beds of the Niobrara group crop out on all the higher hill tops. The village of St. James is situated in the valley of Bow creek, below the level of the chalk. In the eastern edge of the village is an exposure of Fort Benton shales, presenting the same characteristics as seen at a recent landslide on the farm of Williams and Smith, a few miles north of Sioux City in Iowa, and at the exposures near Ponca, Nebraska. This shale furnished a very perfect skeleton of a saurian, as it was penetrated in digging a cistern on Sec. 35, T. 90, R. 47, on the Iowa side of the Big Sioux. Another similar skeleton, that was carried about the country some years ago for exhibition purposes, was taken from the same horizon near Ponca. A few weeks before my visit a portion of a skeleton, forty feet in length, was uncovered in excavating in the Fort Benton shales near St. James. On the tops of the hills near the mouth of Bow creek the dark Fort Benton shales are succeeded by the white or cream-colored chalk of the Niobrara division.

St. Helena, about eight or nine miles above St. James, is situated on a high bluff 130 or 140 feet above the level of the Missouri river. The bluff rises as a vertical wall almost from the edge of the water. Between the river and the vertical escarpment the base of the bluff is concealed by a talus composed chiefly of great blocks of chalk; but above the talus, and rising to a hight of forty feet above the water, is an excellent exposure of the dark shales of the Fort Benton group, differing in no essential respect from the corresponding shales exposed at the land slide above the creamery of Williams and Smith, or the shales occupying the same stratigraphical position near Ponca and St. James. Above the Fort Benton shales lie 90 feet of soft chalk belonging to the Niobrara. The Niobrara beds at St. Helena exhibit some points of difference from those seen on the Big Sioux or on the Missouri across the valley in Nebraska. The valves of *Inoceramus* are no longer present in such numbers, but some of the layers are crowded with *Ostrea congesta*. One impression of the peculiarly corrugated muscular scar of *Haploscapha grandis* was noticed. The beds are uniformly chalky throughout, no part of the deposit being as much indurated as the *Inoceramus*-bearing beds near Ponca or Sioux City. The exposure at St. Helena is probably one of the most striking and interesting along the river and Hayden refers to it time and again in the work already cited.

At Yankton, South Dakota, a short distance above St. Helena and on the opposite side of the Missouri the Niobrara beds are developed in great force. A large factory has been established about three miles west of Yankton to utilize the chalk in the manufacture of Portland cement. The part of the formation at present worked into cement lies above that exposed in the bluffs at St. Helena. It presents a breast about forty feet high. Below the base of the present working the chalk is known to descend to a depth of about ninety feet. The Fort Benton shales have disappeared beneath the level of the river; at all events they lie below the level of any observed exposures. On the hill tops above the cement factory the chalk of the Niobrara is overlain by the shales of the Fort Pierre group. Hayden speaks of this group making its appearance on the summit of the hills near the mouth of the Niobrara, but he might have found it 30 miles farther east developed to a thickness of fifteen or twenty feet.

The shales of the Fort Pierre group above the chalk, and of the Fort Benton group below, are highly charged with crystals of selenite, and selenite is by no means uncommon in the shaly portions of the Dakota group near Ponca and Sioux City.

It only remains to say in conclusion with reference to the taxonomy of our Iowa section, that beds one to seven inclusive are the stratigraphic equivalents of beds near Ponca, Nebraska, which Hayden refers to the Dakota group. Number 8 includes beds that at Ponca and St. Helena have been referred to the Fort Benton group by the same author, and the *Inoceramus beds*, No. 9, are the exact equivalents of the lower twenty or thirty feet of the Niobrara group. A part of the *Inoceramus* beds near Sioux City is soft and chalky; but a part, as has been said, is harder, though by no means as hard as ordinary limestone. At St. Helena, Nebraska, and, so far as known, at Yankton, South Dakota, the beds are chalky throughout, the difference being doubtless due to the fact that the Sioux City area was nearer the shore line of the Cretaceous sea in which the beds were deposited. At Ponca *Inoceramus* is about as common as at Sioux City, but the strata in which the shells are embedded are lithologically intermediate between the condition of the *Inoceramus*-bearing layers at Sioux City and the condition observed in the basal parts of the Niobrara group at St. Helena. Furthermore the beds referred by Hayden to the Dakota and Fort Benton group are as well developed at Sioux

City as at Ponca. At Sioux City, however, we have only the attenuated edge of the Niobrara, but that fact in no way disqualifies so much as is developed from being the stratigraphical equivalent of the lower portion of the group as seen in greater force farther up the river.

The three divisions of the Cretaceous recognized at and near Sioux City in reality represent continuous sedimentation over a gradually subsiding sea bottom. The sandstones and shales of the Dakota group with respect to their lower portions at least, were accumulated in a rather shallow land-locked sea. Currents swept the sand back and forth, sometimes building up, and again tearing down, previously constructed beds, and so produced the fine examples of cross bedding, or current structure, so well illustrated near Springdale a few miles northeast of Sioux City. The few molluscan species found in the lower part of the Dakota group indicate the presence of brackish water. The numerous vegetable remains which characterize the group imply that the large volumes of drainage water which maintained the conditions favorable to the existence of brackish water mollusks, carried not only sands, but swept in leaves and trunks of the willow, poplar, magnolia and other forest trees, from the adjacent lands.

As the waters became gradually and progressively deeper owing to subsidence of the sea bottom, the conditions favoring the accumulation of sandstones and the existence of brackish water mollusks disappeared. The shore line was shifted farther to the east. The sediments of the region about Sioux City became finer and settled down in regular layers beyond the reach of disturbing currents. The downward movement of the sea bottom seems not to have been altogether constant during the epoch of the Dakota group. There were occasional oscillations that from time to time permitted the formation of thin beds of sandstone, but before the close of the epoch the amount of sand that reached as far as Sioux City was insignificant and fine clay shales greatly predominated. The shales of the Dakota group gradually merge into those of the Fort Benton. During the second epoch the subsidence had carried the shore line so far to the east that all coarse sands were deposited before reaching the area in question. Before the Fort Benton epoch began the brackish water estuary had long been transformed into a portion of a clear, open sea. At all events during that epoch true marine mollusks such as *Inoceramus* and *Ostrea*

had supplanted *Cyrena* and *Margaritana*, while marine saurians and teleost fishes multiplied and became the dominating types of the oceanic realm.

The soft limestone and softer chalk of the Niobrara group are indicative of deeper water and remoter shores. No gross sediments from the land reach as far as Sioux City. Not since the earlier part of the Dakota group had it been possible for leaves and twigs of forest trees to be carried into the region. It was during the Niobrara epoch that the subsidence reached its maximum, and the maximum extension eastward of the Cretaceous sea was attained. At the close of the Niobrara the upward movement of the land began; the sea withdrew,* and shales of the Fort Pierre group were deposited above the chalk from Yankton westward.

When we recall the fact that the three groups recognized at Sioux City and Ponca represent the effects of continuous sedimentation over a subsiding sea bottom, it will be seen that the question of dividing the sediments into distinct groups at all is simply one of convenience. Furthermore, any lines that can be drawn between the divisions, if divisions are to be made at all, must be to a large extent purely arbitrary. The upper portions of the Dakota merge gradually into the Fort Benton, while the Fort Benton group passes by gradual transition paleontologically, and in some places lithologically, into the calcareous beds of the Niobrara.

Farther west, where the sea was deeper and the conditions presumably more uniform, the distinctions between some of the groups cannot be maintained, and King has combined the deposits of the Fort Benton, Niobrara and Fort Pierre epochs under the single designation of the Colorado group. Hayden acquiesces in this arrangement in his annual report for 1874, but later in his report for 1877 he makes the Colorado group include only the Fort Benton and the Niobrara, while the two upper divisions, the Fort Pierre and the Fox Hills, are united under the name of the Fox Hills group. The Dakota group, with its coarse sandstones and leaves of forest trees is still recognized as a distinct division.

And this leads to another consideration that is of wide-reaching importance in the correlation of synchronous geological deposits. The sandstones at the base of the Dakota group, near Sioux City, owe their physical and even their paleontological characters to conditions prevailing near the shore. As the bottom subsided

and the shore was moved farther to the east, the character of the deposits at Sioux City changed, but coarse, cross-bedded sandstones and other littoral deposits, charged with leaves and twigs of forest trees, must still have been formed in proximity to the new shore lines. Even while the chalk and limestone of the Niobrara epoch were being precipitated over western Iowa, from solution in clear sea water that contained no trace of sediment, sandstones and shales containing numerous impressions of leaves and branches of terrestrial plants must still have piled up along that more remote eastern shore. But if the shore deposits of the Niobrara epoch could now be found, it is probable that every competent geologist or paleontologist would refer them unhesitatingly to the Dakota group. Deposits absolutely synchronous may present very wide extremes of lithological and paleontological characteristics. It is possible, I think, to recognize a law which I have not seen expressly formulated, but which may run something in this wise:—*Synchronous deposits of the same geologic basin are more likely to present uniform lithological and paleontological characteristics if the geologist traces them along a line parellel to the shore of the basin. If the observations are made along a line that is radial to the geologic basin or at right angles to the trend of the shore, the different parts of absolutely synchronous beds are almost certain to vary in lithological and paleontological characteristics so much as sometimes to make it appear that different parts of the same bed belong to different geologic epochs.*

This law may have greater force in connection with the study of Mesozoic and Cenozoic strata than in the study of the more ancient terranes, but even among the Paleozoics it must frequently have an important application.

SOME RECENT CONTRIBUTIONS TO THE GEOLOGY OF CALIFORNIA.

By H. W. Turner, Washington, D. C.

Geology of the Mother Lode Gold Belt; by Harold W. Fairbanks; American Geologist, vol. vii., 1891, pp. 209-222.

In this paper Mr. Fairbanks gives the chief results of a season's field work along the Mother lode. The author shows a familiarity with modern lithology, and the paper may be regarded as the most important contribution to the geology of the Mother lode

since the publication of professor Whitney's "Auriferous Gravels of the Sierra Nevada," in 1880.

From most of the published material on the subject one gathers the idea that the quartz deposits forming the Mother lode occur uniformly in black clay slates, shown by professor Whitney to be of Mesozoic age. Mr. Fairbanks is perhaps the first to have indicated that the Mother lode fissure does not follow this belt of slates at all points. In Tuolumne county it is noted as cutting "a knob of granite one thousand feet across." At another place, p. 221, Mr. Fairbanks states that "the formation of the Mother lode is the final event in the history of these rocks; no dikes intersect it, and the fissure has broken through all the formations that lie in its path."

That the lode occurs in southern Calaveras county, to the east of the "Mariposa slates,"* does not seem to have been noted. There is a small amount of black clay slate of unknown age at Angel's in one of the mines, but the country rock there is a green amphibolite-schist and the main belt of black slates lies a mile or more to the west. The United States Geological Survey has obtained additional evidence of the Mesozoic age of these slates within the past two years. At the Texas ranch, which lies two and a half miles southwest of Angel's, and to the west of Angel's creek, *Aucella* and ammonites have been found, and an ammonite was obtained from Mr. J. W. Bliss, said to have been found in the black slates about two miles west of Angel's on a branch of Cherokee creek.

On page 219 Mr. Fairbanks makes this statement: "The evidence of fossils recently found in limestone in Tuolumne and Calaveras counties is supposed to favor the Carboniferous rather than the Jurassic. The fossils are few and quite fragmental, and

*The Mesozoic black clay slates of the gold belt containing *Aucella*, ammonites, and belemnites, have been designated "Mariposa slates" on the forthcoming maps of the United States Geological Survey.

There are two main belts of rocks of this series, an eastern belt containing much of the Mother lode, and a western belt extending from Folsom to Salt Spring valley west of the Bear mountains, and further south. The western belt contains numerous small quartz veins, but these have not yet been shown to be highly auriferous.

The locality called Wilkinson's ranch in Whitney's Auriferous Gravels, p. 37, near White Rock station in Sacramento county, is on this western belt of slate. According to professor Whitney, an ammonite was obtained there. The writer found fossil *belemnites* in Salt gulch about two miles northeast of Campo Seco in Calaveras county, and what may also be a belemnite fragment in the clay slates that cross the Tuolumne river a little east of Lagrange.

it seems to me that the evidence is not yet sufficient to classify the limestones of the middle Sierras as Carboniferous." In this connection it might be well to state that the United States Geological Survey has obtained specimens of *Fusilina cylindrica*, *Zaphrentis*, and abundant rounded crinoid stems in limestone in the older rocks of the Bear mountains and their continuation northward. According to Mr. C. D. Walcott, who is regarded as authority both here and in Europe, *Fusilina* is not known to occur below the Carboniferous or higher than the group usually called Permian, which is so closely related to the Carboniferous that it has been relegated to that period by the United States Geological Survey.

The above belt of Carboniferous rocks of the Bear mountains lies just west of the great diabase mass that forms the high ridge of which Bear mountain and mount Joaquin are culminating points. The rocks of it are not in general greatly altered, and consist of fine-grained siliceous rocks (phthanites),* quartzite and limestone, with a good deal of black argillaceous schist.

The broad belt of older rocks lying to the east of the Mother lode is much more altered than this belt of the Bear mountains. Nevertheless, the fossils found in the limestones of this eastern belt are the same. *Fusilina cylindrica* and rounded crinoid stems were found by the writer in the limestone at Hite's Cove in Mariposa county, and rounded crinoid stems occur in the limestone at Cave City and other points along the great belt of limestone.

The prevalent rocks of this eastern belt of older rocks are argillaceous and mica schists, quartzite, and limestone, which is usually crystalline.

The term "Calaveras formation," as used by the United States Geological Survey on the geological maps of the Gold Belt, includes all of the Paleozoic sedimentary rocks of the Sierra Nevada. The two belts of rock just described thus belong to the "Calaveras formation."

Mr. Fairbanks considers the serpentine of the Sierra Nevada as

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*The term *phthanite* is used by the writer to include all the very fine-grained siliceous rocks which have not been subjected to sufficient pressure to be rendered schistose, and in which the silica is largely secondary. These rocks are presumed to have been originally shales and limestones. The silicified shales or jaspery rocks of the Coast ranges and Lydian-stone or *kiesel-schiefer* as defined by Geikie in his Manual of Geology, 1885, p. 122, are included in this term. The term *kiesel-schiefer*, or siliceous schist, is evidently misleading, since the rocks so-called are not schistose.

derived from eruptive rocks, and this origin has been substantiated by the United States Geological Survey, as may be seen in the text of the Sacramento and Placerville sheets, which are now being published, and which form part of the series of the geological maps of the Gold Belt now being issued under the authority of Mr. G. F. Becker. The author is probably right also in regarding some of the granite as later than the serpentine. That it is later than some of the serpentine appears certain from its cutting off the serpentine belt to the southeast of Placerville, as may be seen on the Placerville geological atlas sheet; and a dike of granitoid rock is intrusive in the serpentine area that lies two and a half miles northeast of Oleta in Amador county. Mr. Fairbanks states that some of the granite is later than the Mother lode slates, since south of Mariposa it has cut off and metamorphosed them, and the Mariposa slates at Folsom have been found by Mr. Lindgren to have been altered by the intrusion of the granite.

The fact that the large white masses forming portions of the Mother lode are not entirely quartz, but consist in part of a white magnesian mineral resembling dolomite, is referred to. This was first brought out by professor Whitney, who, to account for the occurrence of these large masses, writes as follows:*

"But this immense mass of quartzose, dolomitic and magnesitic material, to which the name Mother lode, or Great Quartz vein, is applied, is not by any means proved to be a fissure vein or even an exclusively segregated one. It will require much more study than it has yet received before its real character can be stated with confidence. To the writer, it seems, from present evidence, most likely that it is the result of metamorphic action on a belt of rock of peculiar composition, and perhaps largely dolomitic in character."

On page 217 Mr. Fairbanks presents a somewhat similar theory as follows: "That those portions of the lode so enormously expanded are simply coarse basic dikes of no great regularity or continuity, which, lying in the course of the fissure, have been acted upon in a peculiar way by the penetrating liquids and gases. These, through metasomatic processes, have removed part of the original constituents and substituted others. A strong confirmation of this theory is found in a large body of unquestionably eruptive rock, near Jamestown, Tuolumne county, and about half

*Auriferous Gravels of the Sierra Nevada, p. 332.

a mile from the Mother lode. It has very much the same appearance as the vein matter of the lode, except that there is no mariposite. It is seamed with small veins of quartz and in surface decay produces the same red oxide of iron. The only real difference is that the process of substitution is not so complete as in the Mother lode. Dikes that have undergone a partial change often occur penetrating the Mother lode vein matter, and at times they are slightly impregnated with mariposite."

Mr. Fairbanks' theory is a very plausible one, and it would seem probable that a thorough study of the Mother lode material and of this igneous mass by means of their sections, would substantiate this view if true.

Stratigraphy and Succession of the Rocks of the Sierra Nevada in California; by James E. Mills; Bull. Geol. Soc. Am., vol. 3, pp. 413-444.

Mr. Mills in this paper divides the rocks of the Sierra Nevada into three groups:

Pre-Mesozoic, consisting of sedimentary slates and quartzites,* and eruptive granite.

Lower Mesozoic, consisting of slates, greenstones and limestones.

Upper Mesozoic, consisting of thinly laminated argillites (clay-slates and argillaceous schists) and serpentine.

According to Mr. Mills, granite is the chief pre-Mesozoic rock. His evidence of its age consists in his not having found it intrusive in the Mesozoic rocks and in having found pebbles of it in a Mesozoic conglomerate (p. 429). This evidence, if correct, is entirely sufficient, but must apply to very little of the granite† of the Sierra Nevada. The writer found the granite at Mount In-

*Quartzite is perhaps properly defined as a silicified sandstone in which the original quartz grains have been enlarged by the addition of secondary silica so that there are no longer interspaces between them, but they either dovetail into one another, or present a true allotriomorphic structure. Mr. Mills, however, uses the term to indicate almost any highly siliceous rock. Thus on p.425 both *diabase* and *serpentine* "are still further frequently altered to quartzites." Again on p. 423 he says: "In both cases the quartzite is probably a product of alteration of the *granite* itself." This use of the term quartzite is still further exemplified on p. 440.

†The granite of the Sierra Nevada contains but a small amount of alkali, and is more correctly called a quartz-mica-diorite. Dr. Becker has introduced the term *granodiorite* for the alkali-poor granitoid rocks of the Sierra Nevada. (See the text that accompanies the geological maps of the Gold Belt now being issued.)

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formation, and apparently interstratified with limestone containing Carboniferous fossils, in Calaveras county, are pebbles of diabase. Some diabase is presumably, therefore, of pre-Mesozoic age. The western belt of the Calaveras formation contains considerable areas of fragmental rocks of the diabase and prophyrite series. These areas present every evidence of being of the same age as the enclosing sedimentary rocks, that is, Carboniferous. (See Placerville and Jackson atlas sheets.)

On page 437 is described a belt of argillite and limestone that occurs between Campo Seco and Mokelumne hill. Mr. Mills refers this belt to his Lower Mesozoic, apparently on its general lithologic character. This is the western belt of the Calaveras formation already referred to, and the limestone of this belt contains *Fusilina cylindrica*, which has thus far not been found higher than the Permian.

The Upper Mesozoic group of Mr. Mills is characterized by thinly laminated slates and serpentine. The latter rock appears to occur chiefly in the lower part of the Upper Mesozoic. Thus on page 431, "It is plain, therefore, that in the ascending series the serpentines and the slates which accompany and replace them came before the thinly laminated slates, and that the latter are at the head of the whole series of metamorphic rocks of the Sierra."

Northeast of Pence's ranch, in Butte county, is a group of older sedimentary rocks, in the limestone of which are rounded crinoid stems, and in the same limestone *Productus semireticulatus* and *Spirifer lineatus* were recognized by Mr. W. M. Gabb, of the State Geological Survey of California. These fossils are characteristic of the Carboniferous, yet Mr. Mills (page 434), apparently merely because of the association of serpentine with these rocks, "sees no reason to doubt that these limestones with accompanying slates, greenstones and serpentines" are of Mesozoic age.

As may be seen on the Jackson geological atlas sheet, soon to be published, large amounts of amphibolite-schists (part of Mr. Mills' Lower Mesozoic greenstones) are included in the area of the "Calaveras formation" to the north of Angel's, which is so far as known of Paleozoic age. These schists are dynamo-metamorphic rocks which were largely diabase originally and have been subjected to the same displacements as the enclosing sedimentary

schists, strongly suggesting their being about of the age of these schists.

All of the evidence gathered by the United States Geological Survey goes to show that Mr. Mills' subdivisions of the pre-Tertiary rocks of the Sierra Nevada do not hold for the great mass of the central part of the range.

It is also certain that the areas, as mapped by Mr. Mills (see plate 13) about the American valley, will need much modification. Thus a belt of argillite containing limestone* with Silurian fossils has been traced by Mr. Diller and the writer into the large Lower Mesozoic area of the Grizzly mountain, and Mr. Diller has collected both Triassic and Carboniferous fossils in Mr. Mills' Lower Mesozoic area to the east of Red hill between the north fork and east branch of the north fork of the Feather river.

The pre-Cretaceous age of the metamorphic rocks of the California Coast ranges; by HAROLD W. FAIRBANKS: AMERICAN GEOLOGIST, March, 1892.

In this paper Mr. Fairbanks seeks to prove that the peculiar metamorphic rocks of the Coast ranges, silicified shales or phthanites, glaucophane schists and hardened sandstones are not altered forms of the lower Cretaceous (Neocomian) shales and sandstones as held by Whitney and Becker, but that they represent an older series on which the Neocomian rocks (the Knoxville beds) and later Cretaceous are unconformably deposited.

In a paper on the "Geology of mount Diablo, California,"† the writer assumed that the silicified shales and hardened sandstones of that mountain were of the same age as the Knoxville beds, although he found no convincing proof of this. He considered, however, that the diabase and serpentine at mount Diablo are of igneous origin, which conclusion Dr. Becker, after a visit to the district, concurred in.

The diabase at mount Diablo seems clearly intrusive in the phthanites and hardened sandstones, and the metamorphic character of these sedimentary rocks may be ascribed in part to the heat of the intrusive diabase.

Supposing the diabase to be later than the Knoxville shales, it was thought remarkable, and noted in the paper above, that no dia-

*This is the Montgomery limestone of Mr. Diller. See Bull. Geol. Soc. Am. vol. iii, p. 376.

†Bull. Geol. Soc. Am., vol. 2., pp. 383-414.

base dikes cut these shales, and during several years' field work in the Coast ranges as assistant to Dr. Becker, the writer can remember no cases of undoubted dikes of diabase in sedimentary rocks containing Cretaceous fossils.

Supposing Mr. Fairbanks to be correct in considering the Coast range metamorphic rocks as pre-Cretaceous in age, it is likewise probable that the diabase is also of pre-Cretaceous age.

The serpentine at mount Diablo, however, was clearly shown to have been intruded as a dike into the Knoxville shales which, like the dike, stand vertical and contain specimens of *Aucella* on either side of the dike.

There is therefore no doubt of the post-Knoxville age of some of the serpentine of the Coast ranges. Mr. Fairbanks seems likewise of the opinion that the serpentine of the Coast ranges is of post-Knoxville age, having obtained evidence of this in Tehama and Colusa counties (see p. 164 of his paper).

The gabbro described in the bulletin on mount Diablo above referred to as occurring in Bagley creek appears to be a dike in the Knoxville shales which contain *Aucella* on both sides of the dike. This gabbro was thought to be connected genetically with the pyroxenite-serpentine area shown on the geological map. It is probable, therefore, that some of the gabbro of the Coast ranges is post-Knoxville in age.

Professor Whitney came to the conclusion that the silicified shales or phthanites at mount Diablo passed over into the unaltered Knoxville shales which contain *Aucella.* The best proof of this would be to find the *Aucella* in the silicified shales, and this may well be possible, for while these rocks have been thoroughly impregnated with silica and then broken up, and re-cemented by silica they have not been subjected to such pressure as to be rendered schistose. Mr. Lindgren found in microscopic sections organic forms which were considered by professor Leidy probably to be tests of Foraminifera, and these tests, though silicified, retain their spherical form. So far as known to the writer, no molluscan shells have been found in the silicified shales.

If the Knoxville beds are deposited unconformably on the Coast range metamorphic series, it is certain that the basal members of these beds would contain the debris of the metamorphic series. Mr. Fairbanks appears to have noted nothing on this point.

While making a geological map of the Knoxville district for Dr. Becker about eight years ago the writer found conglomerates in the Knoxville beds at several points. A collection was made of the pebbles and matrices of these conglomerates, which specimens have been recently re-examined by the writer with the aid of thin sections.

One of these conglomerate beds lies about two and a half miles southeast of the furnaces of the Reed quicksilver mine, just north of the basalt area. The matrix of this conglomerate (No. 75, Knoxville collection) is a tuffaceous* sandstone containing well preserved specimens of *Aucella*, so that its age is certain. It is composed of fragments of augite, quartz and a little hornblende, with chlorite, calcite and serpentine present as decomposition products. There are also numerous microlitic igneous fragments, which frequently contain larger crystals of augite and plagioclase and are evidently of the porphyrite series. Some other rounded fragments seemed to be phthanite. Augite is so abundant in the rock as seen in thin section that it might almost be called a diabase-tuff. This rock seems likely to have been formed from material derived chiefly from the secular disintegration of rocks of the diabase series. One of the larger pebbles imbedded in this matrix is a diabase-tuff; another is a typical porphyrite, with idiomorphic plagioclase phenocrysts.

Some conglomerate collected about 650 feet northeast of the last locality is composed largely of small pebbles of fine-grained siliceous rocks apparently indistinguishable from phthanite and, like that rock, cut by numerous minute quartz veins.

At the point called Chaparral Station on the geological map† of the district occurs a coarse conglomerate containing pebbles of quartz-porphyrite, and of a granular rock composed chiefly of feldspar and quartz.

The exposures at Knoxville are excellent and a thorough study of these conglomerates and of the metamorphic rocks there ought to determine the question whether or not the metamorphic series is older. Certainly the facts given above seem to prove that the phthanite and diabases are older than the Knoxville beds.

*This adjective being derived from *tuff* should obviously be spelled with two f's and thus distinguished from *tufaceous*, which is derived from *tufa*.

†See the atlas accompanying Becker's Quicksilver Deposits.

Dr. Becker* has also called attention to conglomerate in the Shasta beds at Riddles, Oregon. He writes in regard to it as follows: "Limestone is more abundant at Riddles than in any part of the early Cretaceous area in California that I have studied, and the conglomerates are much more extensively developed. These seem to form the upper layer of the fossiliferous series in Oregon. They are very coarse and at points in the neighborhood the mass is hundreds of feet in thickness. This conglomerate is evidently extensive. Mr. Brown informed me that he had traced it continuously for over twenty miles. It is noteworthy that the pebbles of the conglomerate are composed largely of highly metamorphic rock, indicating a period of dynamo-chemical action prior to the uplift of the fossil-bearing strata."

While the position taken by Mr. Fairbanks may be correct, it does not appear to the writer that the evidence presented in his paper is convincing. Mr. Fairbanks fails to find any line of demarkation between the metamorphic rocks of the Klamath mountains† and those of the northern Coast ranges. After quoting Whitney to the effect that there is no physical break between the two groups of ranges, and giving evidence of the pre-Cretaceous age of the Klamath mountains, he says, p. 159: "After a most careful tracing of the older rocks of Shasta county southward, I find it utterly impossible to draw a line of demarkation between them and the metamorphics of either Tehama, Colusa, Lake or Napa counties. There is no physical break."

That the Coast ranges and the Klamáth ranges are topographically continuous is apparent to anyone who will examine a map of northwestern California. The question, however, is not as to there being a physical break, but as to the different geological ages of the rocks of the two groups of ranges.

It has been proven, chiefly through Mr. J. S. Diller, that the Klamath mountains are made up of Jura-Trias and Carboniferous rocks, a continuation in fact of the auriferous slate series of the north end of the Sierra Nevada. The evidence on this head will be presented in a forthcoming paper in the bulletin of the Geological Society of America by Mr. Diller.

*Bull. Geol. Soc. Am., vol. 2, p. 203.

†This term has been introduced by major Powell for all of the high mountains in northwestern California, including Scott, Trinity, Yallo Bally, Bully Choop, etc. See text of Lassen Peak sheet by J. S. Diller.

Mr. Fairbanks also found several localities of fossils in these mountains, but does not state what the fossils are.

Mr. Diller in the article above referred to, and Mr. Stanton, in a paper in the same bulletin, also soon to be published, produce evidence of the unconformity of the Cretaceous series of the Coast ranges, from the Knoxville beds to the Chico beds inclusive, on the Triassic and Carboniferous rocks of the Klamath mountains, and find evidence also of continuous sedimentation in northwestern California in the Cretaceous series as shown by the fossils.

If, therefore, the metamorphic rocks of the Coast ranges can be shown to be of the same age as the metamorphic rocks of the Klamath mountains, then the entire series must be pre-Cretaceous in age. No positive evidence on this head seems yet to have been produced. The two sets of rocks are very different lithologically, the rocks of the Klamath mountains having been brought into their present metamorphic condition chiefly by dynamo-metamorphic alterations, while the metamorphism of the Coast Range series is more a chemical one, characterized particularly by silicification, although dynamo-metamorphism also played an important part.

From the following extract from the Geology of California, vol. I, J. D. Whitney, p. 363, it would appear that the line of demarkation between the two sets of rocks is quite sharp: "At and north of Crescent City, a plain stretches along the ocean for about twenty miles, having a width of six or seven miles in places. The metamorphic slates make their appearance along the beach, as is well seen about four miles to the east of the town, where the sea washes the base of the hills. These slates continue south to the mouth of the Klamath river where as we are told there is an entire change in the character of the formation, the metamorphic rocks of the Coast ranges coming down to the sea at this point and extending along the shore far to the south. The auriferous slates crop out in reefs and on the main land near Crescent City, forming the promontory near which the town is built, and they extend north for a mile or more where they disappear under a covering of Tertiary sandstone."

Mr. Diller also informs me that in going west over the Klamath mountains he noted in the vicinity of Mad river a marked change in the lithologic character of the rocks, those to the east

of the river belonging to the auriferous slate series, and those to the west to the Coast range series.

Mr. Fairbanks also appears to recognize a difference in the two sets of rocks. On page 158 he writes: "The granite mass of the Trinity mountains terminates abruptly on the south, being cut off by a body of massive serpentine which forms the summit of Bully Choop, one of the highest peaks of the Coast range. Directly south of the serpentine along the crest of the range we encounter green talcose and granitic schists in which the silicification characteristic of the Coast range metamorphics is well developed. The schists are somewhat crumpled with the appearance of minute veins and bunches of quartz which follow the cleavage planes in an irregular manner. These rocks are penetrated for several miles by porphyritic dikes, evidently offshoots of the granite on the north. This is positive proof that their period of upheaval dates back to the extrusion of the granite."

It is to be regretted that the author has not given the reader a more exact lithological description of these porphyritic dikes. The evidence above presented can hardly be regarded as "positive proof" of the relations of the Coast range metamorphics to the granite of the Trinity mountains.

On page 160 occurs the following: "The line of contact between the Cretaceous and the older rocks has been particularly favorable for the intrusion of the peridotitic rock from which the serpentine has been derived, and this together with the general covering of the rocks with soil makes it hard to find good exposures. The best contact observed was on Elk creek in Colusa county; here the soft black shales rest directly against the green silicified schists. A few hundred feet distant the shales have a dip of 40° to the east; as the contact is approached they dip more and more, finally becoming somewhat broken and reversed, while for several feet adjoining the schists they are crushed to a clayey mass. The change to the vertical green schists is abrupt. Towards the crest of the mountain, five miles away, they become more silicified. Black slates and hornblende schists are also to be observed in places. The clay at the contact has been formed by an upward movement of the metamorphic ridge, a condition noticed at several points farther south, and which, to a certain degree, obscures the non-conformity. This is undoubtedly the reason for the apparent conformity between the Aucella-bearing

strata and the metamorphics of mount Diablo mentioned by Mr. Becker as a proof of the unity of the two formations."

Mr. Fairbanks' description of his "best contact" in the above paragraph seems certainly to apply not to an unconformity, but to a fault which perhaps might as readily occur between metamorphosed and non-metamorphosed beds of the same age as of different ages.

On page 164, the serpentine of the Coast ranges is referred to and all considered as resulting from the alteration of basic igneous rocks. This was shown to be true by the writer of the serpentine of mount Diablo and from specimens in the National Museum it appears to be likewise true of the serpentine of the San Francisco peninsula and of New Almaden. It has been likewise clearly shown to be true of the serpentine of the Sierra Nevada by Mr. Diller, Mr. Fairbanks, and the members of the California Division of the United States Geological Survey.

However, it has been proved by micro-chemical and micro-optical tests by Messrs. Becker and Lindgren* that various minerals in the Coast range sandstones are altering to serpentine and it is the opinion of Dr. Becker that this metamorphism has resulted in forming considerable bodies of serpentine.

Mr. Fairbanks concludes his paper with the following, pp. 165 and 166: "From the foregoing illustrations coupled with my own observations I think we can safely say that no important non-conformity exists in the Cretaceous and that it is utterly impossible that the great upheaval of the Coast ranges could have taken place at the close of the Gault or Shasta period, as Dr. Becker has lately affirmed. A small unconformity undoubtedly exists due in part to the eruption of the serpentine and in part to an uplift accompanying it. The extrusion of such an immense body of igneous rock as that near Knoxville, ranging from three to five miles in width and twenty miles long, must have pushed back and tilted the Knoxville shales to a considerable extent."

While there is thus evidence that the main metamorphism of the Coast range rocks occurred before the deposition of the Knoxville beds there is here granted by the author a post-Knoxville disturbance accompanied by the extrusion of serpentine. Now serpentine is a very abundant rock in the Coast ranges. It occurs almost everywhere associated with the phthanites, hardened

*Monograph on the Quicksilver Deposits, pp. 122-126.

sandstones, diabases, and glaucophane schists, and with the Knoxville shales. The area at Knoxville is by no means the only large one; another as large or larger occurring to the west and southwest of New Idria. If all these serpentines are post-Knoxville in age it follows that the upheaval that accompanied their extrusion must have been felt over a considerable area of country. The extrusion of the serpentine must have occurred before the deposition of the Wallala beds (middle Cretaceous) for they were shown by Dr. Becker to contain rolled fragments of that rock.

While at Knoxville during the quicksilver investigation the writer noted a conglomerate near Eticuera creek, some distance to the southeast of the town. This conglomerate contains waterworn nodules of the limestone of the Knoxville beds in which are well preserved *Aucellæ*, indistinguishable from those occurring at Knoxville in exactly similar limestone. There are also numerous pebbles of quartz-porphyrite in this conglomerate, the sandy matrix of which contains well preserved belemnites, presumably *Belemnites impressus*, Gabb. This conglomerate may be supposed to represent the Horsetown or late Shasta beds, which according to Dr. White correspond nearly to the Gault of Europe. This would presuppose an upheaval at the close of the Knoxville epoch and it may well be that this upheaval was caused by the extrusion of the serpentine, no pebbles of which, however, were noted in the conglomerate above described.

Notes on a further study of the pre-Cretaceous rocks of the California Coast ranges; by HAROLD W. FAIRBANKS; AMERICAN GEOLOGIST, February, 1893.

In the paper just reviewed Mr. Fairbanks treats of the geology of the northern coast ranges, and in the present paper of the district from San Francisco south. The extreme southern coast ranges are also treated of, but as they are not directly concerned in the question of the age of the Coast range metamorphic series, no remarks will be made upon that part of the paper. In general it may be remarked, that the author has revised the geology of a very large district, comprising in fact most of California, in a remarkably short time.

On page 70 of the present paper occurs the following: "In my former paper I traced the Paleozoic rocks of Shasta county, part Carboniferous and part probably Devonian, south along the

main coast range to San Francisco bay. The lithological features of the series were quite constant the whole distance, sandstone, slate and banded jasper predominating. The effects of intense dynamical action, resulting in crushed and contorted strata, and secondary silicification, in which these strata were filled with a network of minute quartz veins, were seen to be constant and distinguishing features. With the exception of fossils of probable Paleozoic age from western Tehama county, none were found in this older series." The age of the metamorphic series is here definitely stated to be Paleozoic.

On page 76 the author writes: "As far as I can learn, but two specimens of fossils have been found in the metamorphic rocks of the central coast ranges. One was an Inoceramus, presented to the old state survey by Major Elliot, who found it on Alcatraz island, San Francisco bay." This *Inoceramus* was identified by Dr. Gabb, paleontologist of the California survey, who named it after the discoverer. Dr. Gabb seems to have had no doubt of the fossil being an *Inoceramus*. It is figured and described in the Paleontology of California, vol. 2.

According to the edition of 1889 of Nicholson and Lydekker's Paleontology, this genus is confined to the Mesozoic. Mr. Fairbanks disposes of this evidence of the age of the sandstone of Alcatraz island in the following manner:

"A close examination of the island has recently been made, but no traces of any molluscan remains have been found. The sandstone of the island is identical with that of the mainland both north and south, which I hold to be pre-Cretaceous. * * * The specimen from Alcatraz island was not in good condition, and I think there is room for doubt concerning the correct determination of this fossil."

The author writes further on page 77: "The other fossil which has been made use of to determine the Cretaceous age of the coast ranges is a supposed Aucella from the Santa Lucia range, a little east of San Luis Obispo.* It was found by Mr. Turner while gathering material for the report on the quicksilver deposits of the Pacific coast. In 'Correlation Papers,'† Cretaceous, Dr. White speaks of the most southerly known locality of the Aucella as near parallel 37 degrees 30 minutes north latitude,

*Geology of the Quicksilver Deposits, p. 381.
†Bull. U. S. Geol. Survey, No. 82.

that is, in the Mariposa beds, thus ignoring the specimen from San Luis Obispo, which may have been determined wrongly."

The following letter on this point is self-explanatory:

"WASHINGTON, D. C., Feb. 8th, 1893.

DEAR MR. TURNER:

In reply to your note calling my attention to the fact that I had not referred in my bulletin, No. 82, of the U. S. Geol. Survey, to your discovery of *Aucella* at San Luis Obispo, I have only to say that the omission was inadvertent. The specimen which you send me with your note, with the statement that it was found at that locality, is an Aucella of the type that I have referred to *A. concentrica.*

Very truly yours,

C. A. WHITE."

It yet remains to be shown, however, whether or not the sandstones at Alcatraz island containing *Inoceramus* and east of San Luis Obispo containing *Aucella* are of the same age as the phthanites and associated hardened sandstones and diabases. There is a large amount of red phthanite on the San Francisco peninsula where it is largely used in making roads. Whether the "San Francisco sandstone" is of the same age as the phthanite has not yet been proven in a satisfactory manner. My recollection is that there is no phthanite in the immediate vicinity of the sandstone near San Luis Obispo containing *Aucella*, and therefore this find cannot be taken as evidence of the age of the metamorphic series.

The San Luis Obispo sandstone, however, resembles to a remarkable degree the tuffaceous sandstone, No. 75, from Knoxville, which would seem to indicate that it is later in age than the phthanite and diabase.

The best evidence that has been brought forward up to the present time for considering that the Knoxville beds are unconformably deposited on the Coast range metamorphic series appears to be, first, the apparently sharp contacts of the two sets of rocks, and second, the occurrence of the debris of the metamorphic series in the Knoxville beds.

Mr. Fairbanks treats of the rock of the Gavilan range and its continuation southward on page 71. He considers the granite of that range intrusive in the metamorphic rocks, and gives some observations on the relation of the two series in a side gulch of Nelson creek.

The rocks next to the granite, however, are described as being limestone and mica schist. Further up the slope occur phthanites,

sandstone and serpentine, but the granite was not seen in contact with these rocks, although they seem conformable with the limestone and schist below, in which the granite would appear to be intrusive. Although this suggests the granite being later than the Coast range metamorphic series, it can hardly be said to prove it.

The author states on page 72: "This determines the ages of the two formations; and if it is a fact, as I believe it to be, that this granite is identical in age with that forming the great mass of the Sierra Nevada, the metamorphic rocks into which it has been intruded belong to the same series and were uplifted at the same time as the Sierra Nevada."

There is a specimen of the Gavilan granite and one of the gneiss in the collection of the United States Geological Survey obtained there by the writer. This granite is very different from that of the Sierra Nevada. It appears to be indeed a typical granite, and as shown by a thin section is composed of plagioclase, orthoclase, quartz, and biotite, while the granite of the Sierra Nevada is usually hornblendic with very little orthoclase. The two rocks, however, might well be of the same age, or it is even possible that the Gavilan granite is older than that of the Sierra Nevada, much of which is beyond a doubt of Mesozoic age.

It is to be regretted that Mr. Fairbanks has not brought the microscope to his aid in his investigations. The relation of granite to sedimentary rocks could perhaps in this way be made certain, since the intrusion of granite into sedimentary rocks often causes the formation of contact minerals, mica, tourmaline, garnet, etc.

The following is presented merely as a working hypothesis:

1st. That the granite, gneiss and metamorphic limestone of the Gavilan range and similar areas elsewhere in the Coast ranges are Paleozoic and probably Carboniferous in age.

2d. That the phthanites, hardened sandstones, and diabases, are earlier than the Knoxville beds.

3d. That the serpentine, gabbro, and perhaps the glaucophane schist, which is frequently associated with the serpentine, are post-Knoxville in age.

[PALEONTOLOGICAL NOTES FROM BUCHTEL COLLEGE, No. 4.]

THE CLADODONT SHARKS OF THE CLEVELAND SHALE.

BY E. W. CLAYPOLE, Akron, O.

PLATES VII AND VIII.

The gigantic Placoderms from the shales of Ohio, now so familiar to paleontologists, were not the only fishes of its Upper Devonian seas. With them and sharing their empire we now know that there were abundant representatives of the family of sharks. Only during the last few years have the remains of the latter come to light. The earliest specimen was described and figured by Dr. Newberry in his monograph on the *Paleozoic Fishes of North America* under the name of *Cladodus kepleri.* It was found by Mr. Fyler in the Cleveland shale. Another and better specimen, found later by the Rev. W. Kepler, is noticed in the same place. Dr. N. also figures, but without description, what he considered a second species under the name of *C. fyleri.* This was found by Dr. Clark.

From those two specimens we obtained our first and hitherto almost our only knowledge of the form of structure of these early elasmobranchs. Till then nothing was known save by inference from their teeth and spines which were usually dissociated. Being like all the other sharks largely cartilaginous in skeleton, they left no fossil bones or plates to immortalize their existence.

These teeth and spines were named, and genera and species were founded upon them as a provisional and temporary arrangement with the consciousness that in not a few cases they might only represent different parts of the same individual.

These facts will suffice to show the deep interest and immense importance attaching to the recent discoveries in the black shale of Ohio.

Unfortunately the fossils are not very distinct, being, as are most of the specimens from this rock, heavily laden with pyrites. The labor and care necessary for their safe extraction can only be realized by those who have had experience in similar work.

The teeth found with one of the fossils figured by Dr. Newberry clearly pointed to *Cladodus* as the genus to which the fish or rather the teeth belonged. This genus was founded by Agassiz in

1843 for the reception of this form, which is that of a striated and flattened median cusp with two or more lateral denticles, of which if several were present the outermost were the largest. In *Cladodus kepleri* only a single denticle on each side of the main cusp is present. This is represented by Dr. Newberry on Plate XLIV, which also gives us the earliest representation of the fish that carried them. This and Plate XLVI supply all our knowledge on the subject to date, except what we gather from a single ill-preserved specimen found in the Carboniferous limestone of Lanarkshire in Scotland and described by Dr. Traquair to the Geological Society of Glasgow. A short notice of it appeared in the Geological Magazine for 1888. His specimen apparently differs considerably from those found in Ohio, and it is not easy at present to reconcile the characters of the two.

On a careful and critical study of Dr. Newberry's description, and the figures, it appears doubtful if they are sufficiently close for sure determination. He has apparently included more than one species in *Cladodus kepleri*, while of *C. fyleri* there is only a figure. In the light of the material now at hand we may amend the description of the former as follows, restricting it as much as possible to the form to which it most nearly applies.

Cladodus kepleri.

Fish about thirty-three inches in length, with elongated body; rather slender, its greatest breadth being only four or five inches. Head bluntly rounded in front, sometimes almost squarish as preserved. Pectoral fins rounded at tip, about four inches long and with about eighteen strong rays and membranous margin, two to three inches wide at base, front edge about six or seven inches behind snout.

Teeth numerous with a single small denticle on each side of the main cusp and about one-fourth of its hight, striate.

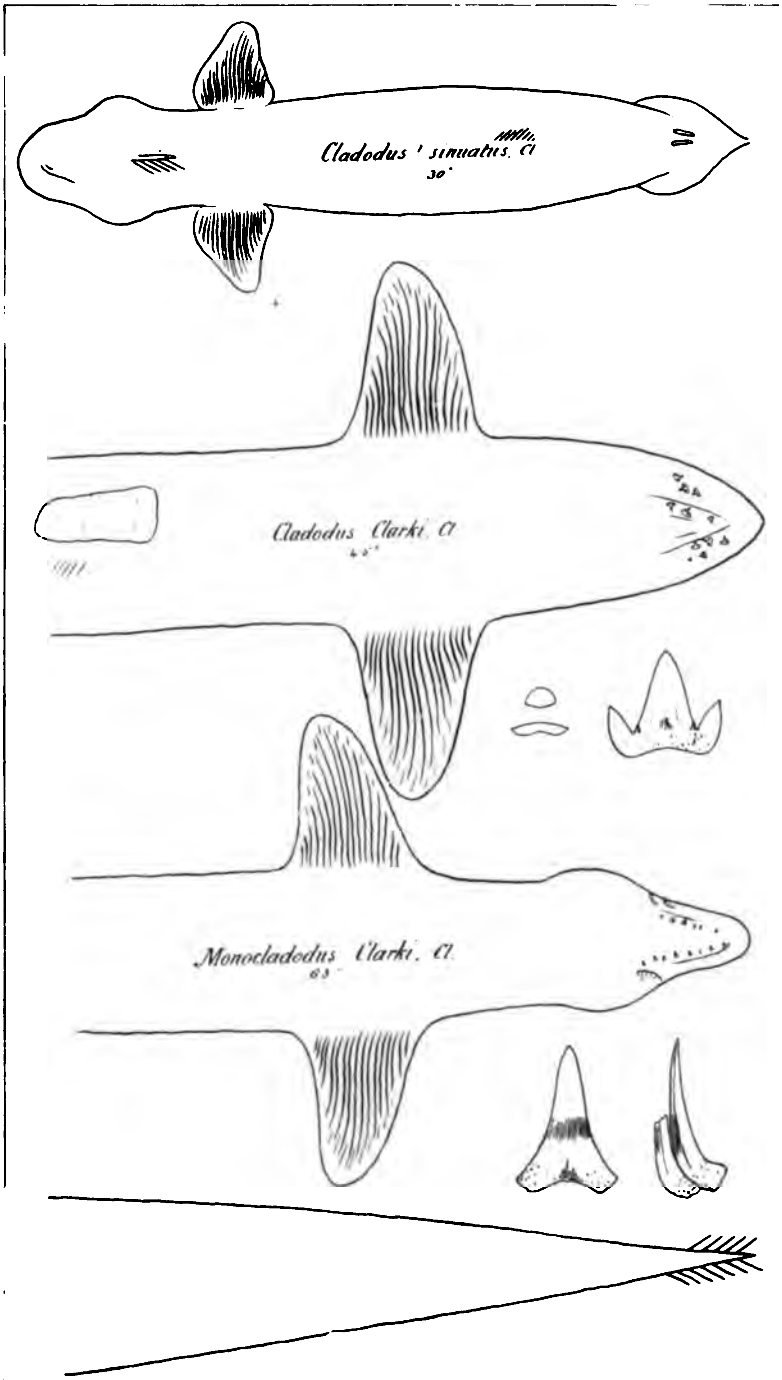
Dorsal surface covered with fine unornamented shagreen, ventral surface with spiral rows of fine, thin, glossy, wrinkled scales, simulating ganoid armor.

Skin on the lower side of the space between the jaws and pectoral fins wrinkled transversely.

No trace of a notochord in any degree calcified.

Ventral fins very soft and only leaving indistinct traces on the stone.

Caudal fin showing a few strong rays above and below.



CLADODONT SHARKS OF THE CLEVELAND SHALE.

Near the tail the lateral margins of the body spread out horizontally, forming a membranous flap in structure resembling the margin of the pectoral fins but without rays.

No sign of a dorsal fin is shown unless it be where the caudal fin mentioned above is described. No trace of spines is seen in any part of all the specimens examined. Possibly there is some error on this point in the figure of *C. fyleri* given by Dr. Newberry.

Cladodus clarki.

Fish about forty-five inches long, body slender, about seven inches wide. Head pointed in front, widening between jaw and pectoral fins. Pectoral fins shaped nearly as in *C. kepleri*, six inches long by four and a quarter inches wide at base; front edge about eleven inches behind snout; rays about eighteen, strong, the larger forking toward the tip.

Teeth numerous, each with a single large denticle on each side of the median cusp and of about half its length, smooth, with slight longitudinal lines, but not striate; very small intermediate denticles at base.

Head covered with fine smooth shagreen. Ventral surface with scales similar to those of *C. kepleri*. Skin on lower side of neck transversely striate. No trace of notochord visible. Ventral fins soft and showing scarcely any trace on the fossil. Hinder end of body not yet found.

In the abdomen of the first specimen discovered lies a large coprolite showing a spiral line apparently indicating the print of the intestinal valve of the sharks.

Branchial openings five, plainly visible just in front of the pectoral fins.

Cladodus sinuatus.

Fish about thirty inches long (twenty-six inches preserved); body less slender than in the foregoing species, expanding, at least in the fossil, behind the pectoral fins and then rapidly tapering backward, the greatest width being nearly five inches.

Head as preserved showing a very marked doubly curved outline which is probably exaggerated by compression, the snout projecting strongly forward and extending six and a half inches in front of the pectorals.

Pectorals nearly straight in front (in the figure the concave curve is too strongly marked); margin membranous and some-

what curved, four inches long by two and a half inches wide at base. Rays about six, thinner and fainter than in either of the former species. The whole fin indicates less power. Branchial rays five, well marked. Teeth not yet known, the reference to *Cladodus* being provisional. No trace of dorsal and but slight indications of ventral fins can be found.

The hinder end of the body is horizontally expanded as in *Cladodus kepleri*, the thin membranous margin resembling in appearance that of the pectoral fins. The bases of two strong caudal fin-rays are visible near the very point of the body, but no other indication of the fin can be detected.

Cladodus rivi-petrosi.

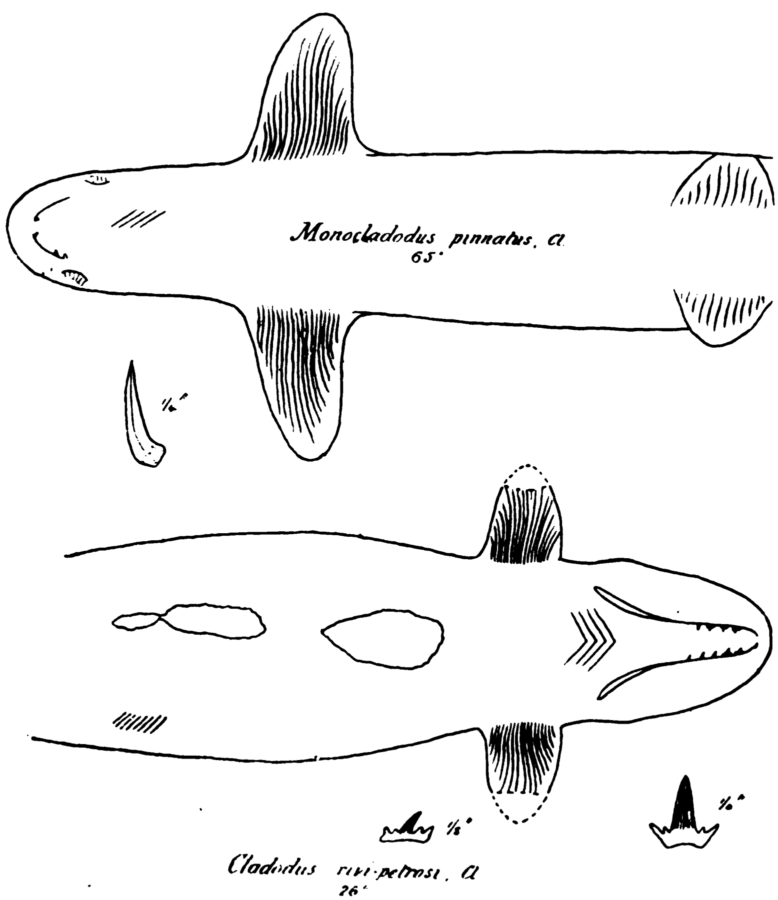
The total length of this specimen as preserved is between eighteen and nineteen inches, indicating a fish of twenty-four or twenty-six inches in total length. Body three and a half inches wide in front of pectorals and widening behind, slightly constricted in front of pectorals, from which to the snout it measures four and a half inches; snout rounded and blunt. Mandibles elongate and narrow, meeting in front and diverging rapidly near the hinder end, curving outward.

Teeth of a strongly cladodont pattern, five preserved in left and four in right mandible, showing a median cusp and two lateral denticles on each side about one-fourth of the hight of the large cusp; outermost largest; median cusp slender, strongly striate to tip.

A second pattern of tooth is shown in the figure, in which the median cusp is considerably curved and the lateral denticles more spreading. It is also smaller, scarcely exceeding one-half of the size of the other. It probably belongs to the other jaw. In front of four of these teeth stands another, almost as in *Monocladodus*, shorter but otherwise resembling the above.

There is some doubt concerning the form of several of the teeth toward the back of the mouth as the lateral denticles are not well shown, but this probably results from imperfect exposure or defective preservation. At least it is wiser at present to infer this than to insist on their absence. Of branchial rays four only are visible, running well forward between the jaws and occupying nearly all the space between them and the pectorals.

Pectorals about three inches long beyond the body and two



CLADODONT SHARKS OF THE CLEVELAND SHALE.

inches wide at base; tips of both missing; rays seventeen or eighteen, radiating from the middle of base, margin slightly membranous. One of the ventral fins is slightly shown with eight or nine rays.

In the place where the stomach of this fish lay during life is a mass of thin ganoid scales, among which close examination reveals a thin and slender jaw set with fine sharp teeth. Obviously we have here the half digested relics of the last supper of the shark and at the same time a proof of the coexistence of a ganoid fish of which we had previously no knowledge. The remains scarcely admit of description or definition but the shark has thus unwittingly preserved for us a trace of other ichthyic life yet to be found in the Cleveland shales. Behind the stomach are the fossilized coprolites including fragments of a similar nature in a more advanced stage.

I have named this species from the Rocky river, where the fossil was found by Dr. Clark.

MONOCLADODUS.

One of Dr. Clark's specimens shows, in spite of the necessary indistinctness incidental to a pyritized fossil, points of difference so strongly accentuated that it cannot strictly be included in the same genus as those already described. Yet in general appearance it so closely resembles them as to indicate a very close relationship. The chief difference lies, as will be seen in the description given below, in the teeth, and for these reasons I have chosen the term *Monocladodus* for the fossil.

In mere size this fish is very distinct, far exceeding all those above described and this character would suffice for specific distinction. But the marked divergence in the form of the teeth seems to warrant something more than this. Though a few so-called *Cladodus* teeth are known in which the lateral denticles are exceedingly small, and perhaps one or two in which no traces of them can be seen, yet it seems on the whole preferable to adhere to the technical description and exclude from *Cladodus* all that do not exhibit them.

Monocladodus clarki.

Fish about 63 inches long, slender, about eight inches in greatest width behind the pectorals. Head rounded in front, somewhat sinuous at the sides, constricted in front of the pectorals. Pectorals very large and strong, eight inches long by five and a

half inches wide at base, and measuring twenty-two inches from tip to tip; fore margin curved backward, thirteen and a half inches behind snout; hind margin nearly straight; rays about twenty, very strong and bony, the longer forking toward the tip; margin membranous.

Teeth numerous, well preserved, in two rows as shown in the figure, nine in one and five in the other, each consisting of a single cusp without lateral denticles, slightly striate below and rising from a forking base; base not projecting in front but extending backward inwardly as shown. In front view these teeth are strongly suggestive of the outline of *Lamna*, though the resemblance disappears on examination of their bases.

Striation moderately strong and not as in the former species consisting of a merely uneven surface; front face of cusp nearly flat; hinder face curved or doubly sloping.

A peculiar feature of the dentition of this fish is the fact that the teeth stand in pairs one close behind the other, as shown in the small figure. The outer one is frequently broken, but this has evidently been done during fossilization or extraction. At least four of those in the left mandible show this double character, and more than one of those on the right side. Some of the front teeth show what is apparently a small cusp lying close in the fork of the base of the larger one. These do not present the appearance of wear or of fracture as is usual in the outer row of the teeth of sharks where they are passing out of use, though this is probably the explanation of the position of the double teeth at the back of the jaw.

No trace of the membranous expansion near the tail is seen in this fossil as in the *C. sinuatus*, though in this region the slab was badly weathered before it was discovered. Its absence cannot therefore be inferred.

The caudal fin is, however, unusually well shown and indicates a considerable hindward extension and attenuation of the body. Four or five strong fin-rays are visible above and below.

Monocladodus pinnatus.

The single specimen representing this species is less perfectly preserved than are most of the others, and were it not for a single feature I should hesitate to consider it distinct. In length it apparently somewhat exceeds *Monocladodus clarki*, but the hinder

end is lacking. The head shows, so far as can be determined, little of that constriction or neck that is so plainly marked in some of the other species. Its length from the snout to the front line of the pectoral fins is less than in *M. clarki.* But the pectoral fins are larger and more powerful than there, measuring from tip to tip at least twenty-four inches. In other details also we find a noteworthy difference. The mandible is only four and a half inches long, or about half as long as in the other species, and the teeth were apparently set in a circular form. They are of the general form of the type with one slightly curved median cusp and a base extended on the inner side, but they are more slender than in *M. clarki* and are not striate. Remnants of the eye capsules are visible, as in some of the other species.

The most striking character of the specimen and the one which most readily distinguishes it from all the others is the great strength of the ventral fins, whence comes the specific name. In none of the others are these organs more than just visible, whereas here they equal the pectorals in solidity though not in size. They are short and rounded and contain about twelve strong bony rays largest in the middle.

On the whole these characters seem to warrant a distinction and I therefore propose to call it *Monocladus pinnatus.*

It is not probable that in all details the outlines here given are minutely correct. Pressure and mineralization have doubtless somewhat modified the shape of these fishes, but I have considered it advisable to represent them as they appear rather than to attempt any restoration beyond the effacement of slight obvious imperfections especially in the margin. Beyond question future research and better specimens will introduce changes and improvements. But I think all the species here named can be differentiated by characters that can be readily recognized where the organs are present.

I will not here enter on the discussion of the many interesting and important questions connected with the discovery of these cladodont fishes. This must be deferred to a future number of the AMERICAN GEOLOGIST, as also the consideration of some other material less distinct and less fully examined.

DEEP WELL AT DELORAINE, MANITOBA.

By J. B. TYRRELL, M. A., etc., Ottawa.*

The following paper is in part a reprint of an article published in the transactions of the Royal Society of Canada, Vol. IX, 1891; but at the date when that article was sent to the press, the well had not reached a depth of more than 1800 feet, and the section had not reached the bottom of the Benton shales. Now, however, the well has reached a depth of 1943 feet, and the drill has descended 108 feet into the Dakota sandstone, which is the formation from which large supplies of artesian water are obtained in Dakota and other states to the south, and which is the only underground source from which a plentiful supply of good water could be hoped for in this part of Manitoba. A strong flow of water was obtained, but it will not rise to the surface, and is said to stand about a hundred feet below it. Boring has consequently been discontinued, and the question whether it will pay to pump water out of the well, or what supply of water can be obtained from it, yet remains to be solved.

The well was sunk by William Ward for the town of Deloraine, which is situated at the terminus of the Pembina Mountain branch of the Canadian Pacific railway. The town is in the southeast quarter-section of section 10, township 3, range 23, west of the principal meridian, in Manitoba. The well is about a hundred yards north of the railway station, on a level alluvial or lacustral plain stretching northward from the base of the Turtle mountain towards the Souris river. It was begun in November, 1888, in the hope of finding a large supply of water at a moderate depth, for there is no permanent stream in the vicinity, and the water of Whitewater lake, which lies on the plain about three miles distant, is quite highly charged with sulphate of soda and other saline ingredients.

The machinery used was a percussion drill, supported by jointed rods, and worked by a small stationary engine. The well is cased with iron tubing, which decreases in diameter with the increase in depth, the smaller sizes sliding down within, and extending below the larger, which latter, therefore, merely serve to support the upper

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portion of the smaller. The following are the diameters and depths of the various casings: 6¼ inches, 658 feet 7 inches; 5¼ inches, 1226 feet 10 inches; 4¼ inches, 1777 feet; 3¼ inches, 1920 feet.

The drillings were raised with an ordinary sand pump. In many parts of the well water had to be poured in to enable the drill to work, and the drillings to be removed; but when the Dakota sandstone was reached the water rushed into the casing, carrying along a large quantity of sand which filled the tube for about 250 feet. This sand packed very hard and was taken out with some considerable difficulty. Afterwards the water rose more quietly to a hight of about 100 feet below the surface, where it stands at present. The water is slightly saline, an analysis by Mr. Hoffmann of the Canadian Geological Survey showing it to contain in an Imperial gallon (=1.2 American or wine gallon) chloride of sodium 309 grains, bicarbonate of soda 94 grs., sulphate of soda 28 grs., other ingredients 15 grs.

In June, 1889, the well had reached a depth of 975 feet and up to that time no clearly-marked specimens had been kept, and the log is given below very much as it was received from the driller.

At a depth of 1050 feet the collection of a systematic series of specimens from every five feet was begun, and was carried down to 1285 feet, between which depth and 1335 feet six specimens were obtained, numbered merely in consecutive order. This latter depth was reached in October, 1889, and then operations were suspended for a short time through lack of the necessary funds to continue the work. During this month the writer paid a short visit to Deloraine, examined as far as possible the work done up to that date, and obtained from Messrs. Stuart, Martin and Cowan the specimens collected. In company with the same gentlemen a visit was also paid to the northern boundary of the Turtle mountain, and the beds composing it were hastily examined.

During the following winter work on the well was resumed with theassistance of grants from the Canadian government and the Canadian Geological Survey, and with very few exceptions specimens were kept from every five feet down to a depth of 1660 feet.

Below 1660 feet specimens were collected at irregular intervals, and especially wherever there appeared to the driller to be any change in the character of the rock. The work also received the constant attention of Dr. Selwyn, director of the Canadian survey,

and all available information has been placed by him in the hands of the writer.

The occurrence of a band of "greensand," composed of the casts of foraminifera in glauconite, at the base of the Benton formation, is an interesting new feature in the geology of the western Cretaceous.

The following is a synopsis of the log as at present determined:—

HIGHT OF SURFACE IN FEET ABOVE SEA LEVEL, 1,644.

No.	DESCRIPTION.	Thickness of layer in feet.	Depth of bottom of layer from surface.	Hight in Feet above Sea.	FORMATION.
	Black soil	3	3	1641	....
	Clay, with some small pebbles...............	30.5	33.5	1610.5	Pleistocene. 91 feet.
	Hard blue clay, with pebbles	56.5	90	1554	
	Fine black sand and gravel	4	94	1550	
5	Light blue-grey shale.....	56	150	1494	Pierre. (Odanah series.) 292 feet.
6	Black sand, with water....	.5	150.5	1493.5	
7	Blue shale................	235.5	386	1258	
8	Soapstone, with thin layers of lime rock.......	401	787	857	Pierre. (Millwood series.) 664 feet.
9	Blue clay, with round "*boulders*"	188	975	669	
10	Dark blue-grey shale......	75	1050	594	
11	Grey shale................	25	1075	569	Niobrara. 545 feet.
12	Mottled grey calcareous shale.................	200	1275	369	
13	Dark non-calcareous, or but very slightly calcareous, shale	135	1410	234	
14	Grey calcareous shale.....	185	1595	49	
15	Dark non-calcareous shale.	215	1810	−166	Benton. 240 feet.
16	Dark greenish-grey shale with many casts of foraminifera in glauconite	25	1835	−191	
17	Sandstone with rounded grains................	108	1943	−299	Dakota. 108+feet.

Nos. 1 and 2.—These are not improbably stratified deposits laid down in the bottom of the postglacial lake Souris, which stretched northward from Turtle mountain and covered the country for many miles around Deloraine. Near the foot of the mountain the land in places becomes gravelly, and occasionally a few boulders are scattered over it. A couple of miles south of Deloraine the surface rises in an easy slope for about fifty feet to a wide, even terrace that runs back to the base of the higher and rougher portion of the mountain. It clearly represents one of the shore terraces of

an ancient lake, but the extent of the lake has not yet been clearly defined.

No. 3.—This is undoubtedly a hard blue-grey unstratified till with pebbles and boulders. Similar till has been thrown out of the railway tank well at the Deloraine station, which was dug to a depth of a hundred feet, passing through the Pleistocene deposits into the underlying Cretaceous shales.

No. 4.—This bed would appear to be a coarser-grained till, but whether it differs in age from the till overlying it is uncertain. At the bottom of this layer a moderately strong flow of water was obtained, rising to within twenty-five feet of the top of the well. It is more or less impregnated with sulphate of soda.

No. 5.—A light bluish-grey, moderately hard, non-calcareous clay shale, typical of the Odanah series. Excellent specimens of this shale were obtained from the railway tank well, a few hundred yards to the west. This series has already been described by the writer,* and was previously very well described by Dr. G. M. Dawson,† as the upper portion of his Pembina Mountain group, from exposures in the valley of the Pembina river, etc. During the summer of 1890 the same formation was traced in the valley of the Assiniboine river, from the mouth of Arrow river to the vicinity of Oak lake, on the Canadian Pacific railway, and near the latter place was found to contain a few fragmentary fish remains, with the shell of an *Ostrea?*, and impressions of portions of the prismatic shell of *Inoceramus*. Prof. Culver‡ also states that similar shale outcrops as far south as La Moure, near the south line of North Dakota, and that in it he succeeded in finding a few fossils, the best an *Inoceramus*, and casts of a little Baculite. These observations clearly prove an extensive areal development for this series of brittle light grey clay shales, and also that it belongs to the marine Cretaceous of the Western Plains. As was stated in the introduction, it is overlain by the coarse Laramie? sandstones of the base of the Turtle mountains.

No. 6.—A considerable flow of water was obtained from this

*"The Cretaceous of Manitoba," by J. B. Tyrrell, *Am. Jour. Sci.*, 3d series, vol. xl, p. 227, Sept., 1890.

†"Geology and Resources of the 49th Parallel," by G. M. Dawson, Montreal, 1878, pp. 81-85.

‡A report on the preliminary investigation to determine the proper location of artesian wells, etc. U. S. Senate Document, No. 222, Washington, 1890, p. 59.

thin band of sandstone. The almost utter absence of sandstone in the Pierre of this section is very noticeable, since sandstone enters so largely into the composition of the same formation farther west.

No. 7.—Apparently the same as No. 5, giving the Odanah series a thickness in this well of 292 feet.

Nos. 8 and 9.—In all probability these are both included in the Millwood series, representing the lower dark grey shales of the Pierre formation. The "boulders" are nodules of calcareous ironstone such as are found in abundance in this formation on the banks of the Assiniboine river, in the vicinity of Millwood. Some shells of spiral gasteropods are stated to have been found at a depth of 845 feet, but none were seen by the writer.

No. 10.—This band has been placed at the base of the Millwood series, which thus is given a thickness of 664 feet, but some or all of it may more properly belong to the top of the underlying Niobrara formation. If it were given the latter position it would represent the band of dark unctuous clay with much carbonaceous matter, etc., that is placed at the top of the Niobrara formation in Messrs. Meek and Hayden's Missouri section. A specimen from 1010 feet consists in part of a soft bluish-grey clay shale, and in part of a light grey clayey limestone. Another specimen from near the same depth contains a considerable amount of crystalline pyrite.

No. 11.—A very dark grey, soft, unctuous, and very slightly calcareous clay shale, containing a few fragmentary remains of fishes, and at the top a few foraminifera (*Anomalina* sp.), with the cells filled with pyrite. Mr. Hoffmann, of this Survey, states that the loss from this rock on ignition is 18 per cent., representing the amount of carbonaceous matter and water in the dried material.

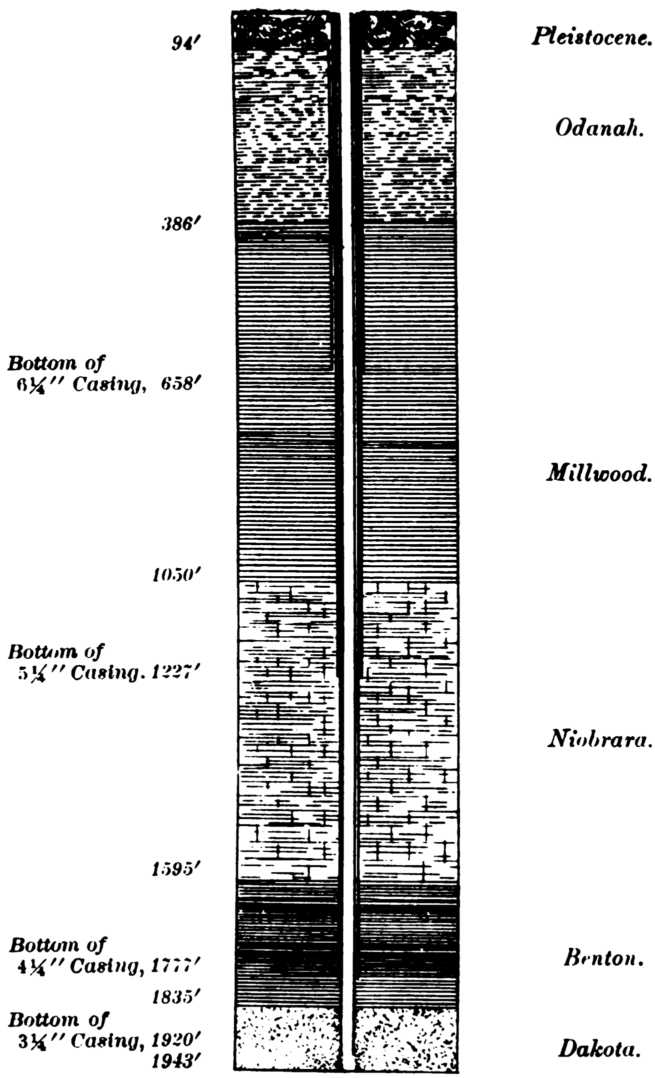
This band has been placed at the top of the Niobrara formation in the section, as it is the highest bed from which foraminifera have been definitely recognized.

No. 12.—A mottled grey calcareous shale or marlite, containing, in varying numbers, foraminifera, prisms of the shells of *Inoceramus*, fragments of fish remains, crystalline masses of pyrite, occasional fragments of the pearly shells of *Ostrea*, and crystals of selenite. The following list gives the results of the examination of the specimens from every five (or ten) feet:—

SECTION OF WELL AT DELORAINE, MANITOBA.

Hight of surface 1644 feet above the sea.

VERTICAL SCALE, 350 FEET = 1 INCH.



1075. Slightly calcareous shale, with fish remains, a few foraminifera, *Inoceramus* prisms, and crystals of selenite.
1080. Soft, moderately calcareous, dark grey, mottled clay shale, with small crystals and crystalline masses of pyrite.
1085. Similar shale, with several species of foraminifera, some fish remains, and a large amount of pyrite.
1090. Similar shale, with foraminifera and fish remains.
1100–1105. More calcareous shale, with large amount of pyrite.
1110. Highly calcareous mottled shale, with fish remains, *Inoceramus* prisms, and many foraminifera.
1115. Dark and light clay shale, both highly calcareous, containing pyrite, prisms of *Inoceramus*, fish remains, and many species of foraminifera, of which Mr. C. Davies Sherborn has kindly determined the following, viz.:—*Globigerina cretacea*, d'Orb., *G. bulloides*, d'Orb., *Cristellaria rotulata*, Lam., *Planorbulina ammonoides*, Reuss, *Anomalina rotula*, d'Orb., *Bulimina variabilis*, d'Orb., *Textularia globulosa*, Ehr., *Verneuilina triquetra*, d'Orb., *Marginulina variabilis*, Neug.
1120. Very similar shale.
1125. Slightly calcareous clay shale, with fish remains, *Inoceramus* prisms, a few foraminifera, and crystals of selenite.
1130. Soft light-grey clay shale, with many fragments of shells of *Inoceramus* and *Ostrea*, and many foraminifera, crystals of pyrite and selenite.
1134–1140. Similar shale, with crystals of pyrite, and a few badly preserved foraminifera and prisms of *Inoceramus*.
1145–1180. Similar shale or marl, with pyrite, fish remains, *Inoceramus* prisms and many foraminifera, *Globigerina cretacea* being especially abundant.
1185–1195. Slightly calcareous shale, a few fish remains, crystals of selenite and a few foraminifera.
1205. Slightly calcareous shale, a few fish remains, and irregular fragments of calcite and selenite.
1210–1245. Similar shale, with pyrite, a few fish remains, foraminifera, and prisms of *Inoceramus*.
1250–1275. Similar shale, with fish remains, prisms of *Inoceramus*, pieces of shells of *Ostrea*, a few foraminifera and crystals of pyrite.

No. 13.—The material brought up by the drill in this part of the boring is generally a very darkgrey, soft, unctuous, and but slightly calcareous clay, from which were separated by washing some fine graphite-like flakes of clay shale. These have much the appearance of the Benton shales elsewhere in Manitoba, and were previously regarded as such by the writer; but as this band comes between two highly calcareous zones, it has been thought advis-

able to group it in with the Niobrara formation. The following list gives the particulars of some of the beds:—

1280. Dark grey non-calcareous clay shale, with a few fish remains and many crystals of selenite.

1285–1295? Dark slightly calcareous shale, with a few prisms of *Inoceramus* and fragments of fish remains.

1300 ? Similar shale, with a few specimens of *Globigerina cretacea.*

1305–1345. Dark, unctuous, non-calcareous clay shale.

1350. Similar shale, with fragments of a nodule of calcareous ironstone.

1355–1380. Similar shale breaking into minute flakes.

1385. Slightly more compact shale.

1390–1395. Similar shale, with a few crystals of selenite.

1400–1405. Similar shale, without selenite.

No. 14.—This series is a downward continuation of the last, the shale gradually becoming more calcareous, till it appears to terminate in a band of coarse fragmental limestone, called sandstone by the driller. From this limestone band there was a considerable flow of water which rose rapidly in the pipe to within eight feet of the top. The water had a flattish taste from the presence of salts of soda. This limestone band is regarded as the base of the Niobrara formation. The following is a serial description of the beds:—

1410. Dark grey non-calcareous clay shale, with a few rotaline foraminifera, and some moderately large fragments of the shell of *Inoceramus.*

1415–1425. Similar shale, with a few fragments of fish remains, but no foraminifera.

1430–1445. Similar shale, with a few prisms of *Inoceramus.*

1450. Lighter grey calcareous clay shale, with large and small prisms of the shells of *Inoceramus*, pieces of shells of *Ostrea*, and a few fragmentary fish remains.

1455. Similar shale, with a large number of foraminifera, *Globigerina cretacea* being especially abundant.

1460–1485. Similar shale, with a few *Inoceramus* prisms, and a greater or less number of small foraminifera belonging to such genera as *Textularia*, *Anomalina*, etc.

1490–1510. A light-grey calcareous shale, with numerous specks of pyrite, many small species of foraminifera, prisms of *Inoceramus*, and pieces of the pearly shell of *Ostrea*, and fish remains.

1515–1555. A harder grey calcareous shale, holding similar organic remains, in varying quantities.

1565. Dark grey slightly calcareous thin-bedded shale, holding a few foraminifera, and fragments of fish remains. A considerable flow of water was here struck and rose to within 200 feet of the surface.

1570. Dark grey non-calcareous thin-bedded shale, without organic remains.

1575. Dark grey clay shale, with many fragments of the shells of *Inoceramus*. With these are a few species of foraminifera of such genera as *Textularia*, *Anomalina*, etc., with fragmentary fish remains, and moderately large masses of pyrite. This gritty or fragmental layer formed the sandstone of the driller, and from it quite a large supply of water rose in the casing.

1580-1590. Dark grey clay shale, with a few corroded prisms of *Inoceramus*, small foraminifera, and fragments of fish remains. When the drillings are washed almost everything is carried away in the water as a fine mud. The latter specimen, when drying, became covered with a white efflorescence of sulphate of soda?

1595. Similar shale, breaking down into thin flakes, and containing small cubical crystals of pyrite, prisms of *Inoceramus*, fragments of fish remains, and pieces of the shell of *Ostrea*, but no recognizable foraminifera.

No. 15.—Consists throughout, as far as could be determined from the specimens, of a dark grey, non-calcareous clay shale. In its upper portion it is apparently very bituminous, and breaks into minute flakes, while below it is somewhat lighter in color, is often harder, and contains minute angular grains of clear quartz sand.

The following is a more detailed categorical description of the beds passed through:—

1600. Dark grey and rather hard fissile clay shale, brought up in fragments, some of which are more than an inch and a half in greatest diameter. It is quite free from calcareous matter, and under the microscope shows no traces of organic remains, but a few globules of pyrite may be seen.

1605-1620. Soft, darkgrey, unctuous, non-calcareous clay shale, breaking into thin, scaly flakes. No trace of organic remains.

1620-1645. Similar shale, with minute fragments of fish remains.

1655. Similar shale with traces of pyrite, mixed with a few particles of fine white soft sandstone, possibly adventitious. The specimen as returned was composed almost entirely of a soft, impalpable clay, and the fragments of shale, etc., were procured by washing a considerable quantity.

1660. Soft, dark grey, fissile, non-calcareous shale, with a few minute fragments of fish remains, and pieces of concretionary nodules of limestone, and crystalline masses of pyrite.

1665–1715. No specimens received, but stated to be a similar dark grey shale.

1720. A large proportion of the specimen received is a soft clay that is readily washed away by the water. What remains is a grey non-calcareous clay shale, much lighter in color than the last, is rather compact, and does not break into thin flakes. It contains a few fragments of fish remains, and some fine irregular angular grains of clear quartz sand.

1730. Similar shale, through which the fine sand is seen to run in thin streaks.

1735. Shale similar to the last with some crystalline aggregates of pyrite, and a considerable number of fragments of a hard, very slightly calcareous fine-grained sandstone.

1745. A similar dark grey clay shale, with a few fragments of soft granular sandstone, but without any of the hard sandy fragments seen in the last specimen.

1800. A light grey, rather hard, fissile, non-calcareous clay shale, with a few small crystals or crystalline masses of pyrite. Some of the fragments procured were an inch or more in diameter, and in one of them was a small imperfect shell of a *Lingula*.

1808. Dark grey, rather hard, thinly fissile, non-calcareous clay shale.

No. 16.—A dark grey or greenish-grey clay mixed with sand, which in the upper portion is composed almost exclusively of casts of globigerine forms of foraminifera in glauconite, while in the lower portion these appear to be largely replaced by rounded grains of white quartz. The specimens examined were as follows:—

1815. The specimens of the drillings consisted of dark-grey soft non-calcareous clay. On washing this mud a large quantity of beautiful green sand is left in the bottom of the beaker. Under the microscope this sand is seen to be composed of casts in *glauconite* of the interior of foraminifera, chiefly of the genus *Globigerina*. With the glauconite casts are a few grains of clear quartz, and a few small particles of shale, consisting of glauconitic casts of foraminifera cemented together by calcite and pyrite.

1820. Dark grey, soft non-calcareous or very slightly calcareous clay, from which a large number of casts of foraminifera in glauconite were washed out. In the drillings was a fragment of a calcareous nodule.

1825. Dark grey non-calcareous clay. The residue, after washing, consisted of well rounded grains of white quartz, and small irregular masses of pyrite, with a few casts of foraminifera in glauconite.

1830. Dark grey, soft, non-calcareous mud. The washed residue is composed largely of rounded grains of white quartz. With these are mixed some small masses of pyrite, and a few casts of foraminifera in glauconite.

No. 17.—Coarse and fine sandstone, often almost incoherent,

but varied with occasional hard bands. The grains, which are chiefly of white quartz, seem to be all well rounded. The top of the formation is a band of hard sandstone on which the casing rested till the rock was undercut beneath it. No specimen of this top band was seen by the writer.

A considerable flow of a slightly saline water was obtained from this sandstone. The water does not rise to the surface but stands about a hundred feet below it.

The specimens of drillings examined are as follows:—

1841. Sand consisting of rather small rounded grains of white quartz, mixed with fragments of clay. Water was here struck, and rose rapidly to the surface.

1843. Coarse sand, consisting of large well rounded grains of white quartz, with some small masses of pyrite.

1857. Similar coarse rounded quartz sand, with fragments of calcareous nodules.

1863. Similar well rounded quartz, a few small masses of which are firmly cemented together with pyrite.

1943. Fine, light brown, well rounded, homogeneous quartz sand. The boring did not reach the base of the Dakota sandstone.

EDITORIAL COMMENT.

Prof. Youmans and the United States Geological Survey.

In the April number of the *Popular Science Monthly* is an article by professor E. W. Claypole, criticising the assailants of professor G. F. Wright for their severe and in several cases uncourteous attacks upon him on occasion of his recent publication of "Man and the Glacial Period." The paper is a merited and reasonable rebuke, and though sometimes severe it does not exceed the bounds of justice or go outside the coterie chiefly concerned.

In the same number the editor of the *Monthly* has printed a caustic note calling attention to Dr. Claypole's article and adding some severe criticisms of his own. So far as concerns the writers at whom the remarks in the former paper were aimed these are richly deserved and will we trust be read with profit. Professor Youmans tells them some good and wholesome truths which it

would have been as well if they had recalled before they put their pens to paper in their recent attacks on a fellow-geologist. He has no mercy for the officials who make use of their position to attempt to crush out a scientific rival of whom they seem to be either jealous or afraid. His note concludes with a sweeping condemnation of the United States Geological Survey on account of its dictatorial and inquisitorial conduct.

While thus fully admitting that the flagellation administered by professor Youmans is richly deserved by the high offenders who have in so flagrant a manner betrayed the confidence of the country, we feel that the words employed are scarcely sufficiently guarded to avoid striking the innocent with the guilty. Dr. Claypole's paper is strictly limited to the criticism of the actual offenders who may be identified by the references given. Thus none are touched save those who have committed the faults. But in including the whole staff of the United States Geological Survey within his castigation professor Youmans has, we fear, punished with less discrimination. It is seldom just to hold a whole company responsible for the faults of a few. The survey corps is composed of men of very different natures and qualifications, and we doubt not that there are among its members not a few whose nobility would scorn to utter the words which have been uttered in this controversy. They may not have been willing to come out as men should do in condemnation of an unprovoked wrong. Professional etiquette may have been too strong for their higher feelings. But we cannot for that reason hold them guilty on the main count.

We may add yet further that we believe from personal knowledge that not a few of the professional members of the Survey (late and present) must feel the same indignation that has been expressed in so many quarters at the wanton assault upon professor Wright, whether they agree with his views or not. For these reasons we regret the general terms employed by professor Youmans and wish that he had been more discriminating in his censure which would then have been more effective. But for those by whom they are deserved, such as the writers at whom Dr. Claypole's criticisms are aimed, they are admirably suitable and timely, and all friends of freedom in scientific discussion and elsewhere will thank him for having printed them.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Report of the State Board of Geological Survey [*Michigan*], *for the years* 1891 *and* 1892. Lansing, 1892. Roy. 8vo., pp. 192.

This document sets forth the expenses of the survey from its inception to November 22d, 1892, exclusive of the cost of publication, also contains the reports of Dr. C. Rominger for the years 1881-2 and 1882-3; of Mr. Charles E. Wright for the years 1885-8; of Dr. M. E. Wadsworth for the years 1888-92, made to the State Board of Geological Survey for the years named; also a provisional report by Dr. M. E. Wadsworth upon the geology of the iron, gold and copper districts of Michigan. It is preceded by an administrative report signed by the three members of the board, who are, ex-officio, the governor, the superintendent of public instruction and the president of the board of education. The financial statements disclose some interesting and even remarkable facts.

From 1837 to 1845 the total cost of the survey was $32,829.03, and of the appropriations made, aggregating $40,000, $7,170.97 were "returned to the State" unused.

From 1859 to 1892 the total appropriation has been $160,000 and of this the amount used has been $109,599.33, and the rest of the appropriation, amounting to $63,207.92, has been "charged out," *i. e.*, returned to the State. Since 1871 there has been available an annual fund of $8,000, and during only two of those years has it been fully expended. Between 1845 and 1859 there was no survey in progress. In 1859 the survey was re-commenced, but was interrupted by the civil war, till 1871, when the annual appropriation was begun. Prior to 1871 and after 1859 there were appropriations from the general fund for two years, aggregating $5,000, and during 1861, 1862 and 1870 small sums to pay expenses formerly incurred, $1,080.91.

The non-use of the appropriated fund after 1845 was doubtless due to the death of the state geologist, Dr. Douglass Houghton, who was drowned October 13, 1845,* and who was both state geologist and geological board. The available fund between 1859 and 1862 seems to have been entirely used, amounting to $6,000. A. Winchell was then state geologist. On the revival of the survey in 1869, again under Prof. Winchell, the annual appropriation was $8,000. Prof. Winchell served two years and resigned. The years 1869, 1870 and 1871 are unrepresented in the schedule statement (on p. 24), but, beginning with 1871 an annual appropriation was available under a general law. The remarkable feature of this schedule is the fact that more than one-third of the available fund of the survey, between 1871 and 1892 has been left un-

*AMERICAN GEOLOGIST, Vol. IV, p. 129.

used so long in the treasury of the State that finally it was returned to the general fund of the State, the total sum thus lost to geological science in Michigan being something over sixty-three thousand dollars. The same geological board has had charge of the survey during the whole of this period, though the personnel changed nearly every year. The statement of the board contains several strictures on the negligence of their predecessors, and laments the dilatory manner in which the geological survey has been carried on, but properly assigns the cause to the over-burdened and under-paid condition of each of the officials who belongs to the board.

"Should the legislature permit the survey to continue in the future as it has in the past, no definite limit can be fixed as to the time when the survey will be completed. The members of the board are all such *ex-officio*. The governor of the state of Michigan is a hard-worked official. His duties are many and onerous. The superintendent of public instruction has but a meagre salary, and while he receives but $1,000 per annum for his services, the State receives from him in the ordinary discharge of his duties several times that amount. There is no board in the state, perhaps, upon whom so many varied duties devolve as upon the state board of education, and the president of that board, if he does his full duty, cannot be expected to spend much time upon any other board. The present incumbent of that office has given more than six weeks of his time to the survey and has received therefor $45 in per diem."

To remedy the defects pointed out, the board recommend strongly that the commissioner of mineral statistics, now an independent officer, be made a subordinate officer of the board with instructions, with his other duties, to spend his entire time in the service of the board looking after the property and records of the board, and keeping the board informed of the condition of the survey.

That part of the volume which contains a "Sketch of the geology of the iron, gold and copper districts," by M. E. Wadsworth, the state geologist, possesses the chief scientific interest, as it covers many of the prominent unsettled questions of the geology of the crystalline rocks in the Northwest. It embraces an abstract of the results attained by the Michigan Geological Survey, under the late state geologist, C. E. Wright, and by Dr. Wadsworth, and gives a somewhat connected discussion of the different formations and of their relations

Under the term *Azoic*, which he prefers rather than Archæan, he embraces three formations to which he gives local names, viz., Cascade, Republic and Holyoke. The terms Algonkian and Keweenawan find no place in this report. These new terms were used by Dr. Wadsworth first in 1891, for formations whose unconformable relations had been made out by the Michigan survey.

After the presentation of a rather peculiar general classification of rocks, the vicinity of the Volunteer mine is cited as the typical locality at which the Cascade formation was named. Here can be seen the three Azoic formations plainly exhibiting their inter-nonconformity, sepa-

rated by two basal conglomerates. The description would indicate that the Cascade formation is the equivalent of the Vermilion of Minnesota, or the Coutchiching of Manitoba. It is an old hornblende schist invaded by irruptive granite. In the same formation is much gneiss traversed by basic and acid dikes.

The Republic formation embraces breccia, conglomeratic schist, quartzyte, dolomyte, jaspilyte, granite, felsyte, diabase, porodyte and porphyryte. These have a tendency toward chloritic, talcose or hydrous mica schist. The dolomyte is interbedded with quartzyte, and is white, flesh-red, light or dark gray and often silicious. The jaspilyte is the iron-ore rock of the formation. It is described from two points of view, viz., an eruptive origin and a sedimentary origin. The iron ores of this formation are situated, according to the conception presented in the report, between two conglomerates, one being supposed to be at the base of the Republic and the other at the base of the Holyoke, the former being evidently the equivalent of the Keewatin.

The Holyoke formation which is that which corresponds with the iron-bearing formation of the Penokee and the Mesabi ranges (the Taconic of the Minnesota reports), embraces a great variety of lithology, viz.: 1. Conglomerate, breccia and conglomerate schist. 2. Quartzyte. 3. Dolomyte. 4. Argillyte, graywacke and schist. 5. Granite and felsyte (?). 6. Diabase, dioryte and porodyte. 7. Peridotyte, serpentine and dolomyte. 8. Melaphyr or picryte. 9. Diabase and melaphyr.

"The conglomeratic schists are often quite chloritic, and pass into chlorite schists and argillytes without showing any trace of their conglomerate structure." The quartzyte is that which is well known as the basal member of the Taconic in Vermont, the granular quartz, and partakes of the characters of the underlying formation, even shading into and alternating with conglomeratic portions and with chloritic debris. This quartzyte sometimes fills fissures in the underlying formation, causing the appearance of dikes of sandstone, such as those that have been described in California and elsewhere. To such dikes Dr. Wadsworth gives the name *clasolite*, using the term as a generic one, whether the fissures were filled by deposition from above, or by earthquake or water action from below. "It is an open question whether some of the argillytes and schists now found cutting the iron ore beds have not been formed as clasolites rather than as true dikes. A similar formation might be produced by soft clayey rocks, if, when the associated rocks were folded, the clayey material were squeezed into fissures or between beds."

It is not certain yet, according to the report, whether the dolomyte supposed to belong in the Holyoke, may not be rather a member of the Republic.

The upper portion of the Holyoke formation develops into "a peculiar grayish argillitic sandstone which contains some feldspar," and the term graywacke has been provisionally applied to this. It grades into an argillyte and as such furnishes roofing slates, though the rock is so

jointed that the industry has not yet proved to be profitable. Large areas, fifty miles in extent, are supposed to be underlain by such slates. This is a grand feature which allies the Holyoke slates with the Thomson (Taconic) slates in Minnesota, and with the supposed "Lower Cambrian" slates of the Huronian region in Canada southeastward from Vermilion lake in the vicinity of Sudbury.

The hypothetical granite and felsyte of the Holyoke formation consist now of schistose rock, mainly chloritic, cutting the bedding in the form of dikes, and they may instead have originated from "porphyrytes or diorytes."

Peridotyte, serpentine and dolomyte, placed by the report in the Holyoke, compose that rock seen at Presqu' Isle and northwestward from Ishpeming, and these rocks, constituting a geological unit, are regarded as the "youngest of the large intrusive masses seen thus far in the Marquette district." The writer, on the other hand, considers them a constituent part of Dr. Wadsworth's Republic formation, but not altered eruptives in the usual acceptation of that term. The materials of which they are composed were water-stratified, but of the nature of volcanic tuff, originating in Archæan time and "altered" in Archæan time by the waters of an Archæan ocean.

The melaphyr and picryte are problematical, schistose rocks of a dirty brownish or grayish color seen on the islands north of Marquette, supposed to be "altered" andesytes or peridotytes. The dikes of diabase and melaphyr are the youngest of the eruptive rocks of the region, and are not known to cut the "Eastern sandstone." One such dike is known (on Presqu' Isle) to be overlain by undisturbed, horizontal "Eastern sandstone."

According to observations made by Mr. A. E. Seaman in the vicinity of Bessemer, and in T. 46-41, there seem to be two sandstones closely associated with the diabases of the Keweenawan, one of which is indurated, conglomeratic, rests on steeply inclined green schists, and in places is a quartzyte; the other is near adjacent, friable, with spots of deoxidation like the "Eastern sandstone" and contains pebbles of melaphyr and large, angular fragments of indurated sandstone which he considers derivable from the indurated sandstone outcrop adjacent. If this indurated rock be not the underlying quartzyte of the iron-bearing series of the Taconic, Mr. Seaman's reasoning tends to show the occurrence of a break and an erosion interval in the progress of the Keweenawan epoch, of a character quite different from the intervals which separated the eruptive episodes which characteristically composed the history of the lower portion of the Keweenawan.

There is a chapter devoted to the "chemical deposits of the Azoic system." The soft iron ores and manganese deposits are thought to be due to chemical changes in the original rocks brought about by the action of percolating water. The author considers that "rocks of entirely different origin and structure, like sedimentary and eruptive rocks, have been so changed by this action that the resulting forms are indistinguishable from one another except by their geological mode of

occurrence." This is a very comprehensive affirmation of a hypothetical principle with which some geologists would take as broad a negative issue as is implied affirmatively by the author. "Percolating water" figures very prominently in the report, and in all the geological reasoning of the author. He does not assign the origin of the crystalline rocks to the agents appealed to by the "crenitic hypothesis," but he postulates such profound changes by reason of those agents that there is but little choice between Wadsworth and Hunt. It is sufficient here to say that there is a small school of modern petrographers who explain many of the changes which rocks seem to have suffered, from their point of view—being the same changes that Dr. Wadsworth attributes to percolating water—by a mysterious operation named "dynamic metamorphism" in which percolating water plays no part whatever. Without attempting here to make peace between these contrary schools, or to mention any of the difficulties which obstruct the theory which Dr. Wadsworth adopts for the origin of the "soft ores," it is sufficient to say that the application of Dr. Wadsworth's views as to the origin, variations and classification of rocks in general tends to great complexity if not confusion, and to make of petrology and of the geology of the Northwest a vast impenetrable jumble if not jungle.

The Eastern sandstone is considered to be of the age of the Potsdam, of New York. It is found to underlie a small patch of Trenton limestone. This sandstone is thought most likely to be of the age of the Keweenaw Point traps, of the north range, there having been intermittent trap-flows during its accumulation. At least at some places the evidence points that way, but Dr. Wadsworth admits that in other places there is good evidence of a fault line along Keweenaw point, as claimed by Foster and Whitney, and by Irving and Chamberlin, thus making the Eastern sandstone of later date than the traps. This is also indicated by the fact that debris from the traps is found in the sandstone.* He suggests the very probable existence of two sandstones in the "Eastern sandstone," the upper one, which is seen to be first beneath the Trenton would, in that case, probably represent the St. Peter sandstone, and the other, if later than the traps, would be the equivalent of the St. Croix sandstone of the upper Mississippi valley, which is known to overlie unconformably the traps at Taylor's Falls. Between these two is a heavy calcareous member which ought to be represented by some similar layer in the eastern part of the "upper peninsula," and which is probably that which has already furnished some few fossils in northern Michigan.

The "south trap range" is briefly described, and is considered to be made up of trap-flows intersheeted with sandstone, the sandstone being of the age of the Eastern sandstone, the two being as conformable as

*The subject of the age of the Eastern sandstone relatively to the traps was discussed at length in the AMERICAN GEOLOGIST, Vol. I, p. 44. See also Vol. III, p. 342, where is given the first sufficient demonstration that the Cupriferous rocks are of Paleozoic age, as distinguished from Mesozoic.

two such contemporaneous rocks can be. We would suggest here that perhaps the "Eastern sandstone" is not represented by this intersheeted trap-and-sandstone formation, but rather by the other "younger sandstone" which is said to contain debris from the traps and from the older sandstone It is quite possible that this intersheeted sandstone and trap formation is really the basal member of the Holyoke, representing the Pewabic sandstone of Minnesota. That may explain the contrariety of the conclusions reached by Brooks and Pumpelly and Irving, as compared with those of Wadsworth.

There is a chapter by Drs. Lane and Hubbard on certain minerals, others by Drs. Lane and Patton on certain peculiar rocks and their microscopic characters.

The report as a whole is refreshing, for it indicates an earnest attempt to treat the geology of the state of Michigan according to the new methods, which are as different and as much better than the old "Huronian" methods as the principles of William Smith were superior to the floundering efforts of his predecessors. There are some notions in the report which we cannot accept, based sometimes on erroneous, preconceived ideas and sometimes apparently on bad observation. But it must be granted that this, being the first report of the present organization, should be allowed the privilege of making some mistakes, and should be given the opportunity of correcting them in later statements when longer study shall have shown where they are.

Seventeenth report of the Department of Geology and Natural Resources, Indiana.—S. S. GORBY, State geologist, Indianapolis, pp. 705, 20 plates of fossils, Octavo, 1892. With a geological map of the state, which shows, besides the surface distribution of the formations, the location of various economic industries, viz.: Stone quarries, natural gas areas, natural gas wells, oil areas, gas pipe lines and oil pipe lines. Where the drift prevails the map is left blank.

The activities and responsibilities of the state geologist were extended by law in 1891 so as to include the appointment and supervision of the following officers who make reports to him, viz.: Inspector of mines, Supervisor of oils, and Supervisor of Natural Gas. The reports of these officers make the volume largely economical, but it also includes a chapter by S. A. Miller which describes and illustrates more than 150 new species of fossils. It also has catalogues of the butterflies and of the batrachians and reptiles of the state.

Prehistoric America; The Mound Builders, their works and relics. STEPHEN D. PEET, Chicago, The American Antiquarian, 1892. 8vo, pp. 376. Numerous figures and plates.

The author of this volume has been editor of the *American Antiquarian* for many years, and is one of the best known of American antiquaries. He has had ample opportunity to become qualified to produce a thorough work on the Mound Builders, with such consideration of collateral subjects as easily present themselves in studying that mysterious people. Mr. Peet prefaces his discussion of the Mound Builders with a

sketch of their possible ancestors—glacial man—and in this part of the volume geologists will have the more lively interest.

While the author has not been among the credulous in accepting the supposed tokens of paleolithic man in America, he yet gives approvingly the points of coincidence between the European and American discoveries, and he so unites them in his presentation that it is evident that he recognizes a "paleolithic" human age in America. He quotes Dr. Abbott's discoveries in the Trenton gravels and Miss Babbitt's opinions of the quartzes at Little Falls. He figures the Nampa image, quotes Prof. Whitney on the Calaveras skull, and Dr. Flint on the "Eocene or Miocene" human footprints in volcanic tufa in Nicaragua. He considers that Dr. Koch's claims as to the association of human implements with the mastodon (the *Missourium* of Dr. Koch) have been confirmed by the recent discoveries of Dr. Hughey (Aughey?) in Nebraska and by his own in Ohio. In all these cases the bones of the mastodon are mixed with ashes and other traces of fire, arrow-heads and other stone weapons. He also adopts the Davenport elephant pipe, about which there has been much discussion. He classes these among the "mysterious races," of whose origin and whose dates we have nothing certain, further than that they were contemporary or immediately succeeding to the glacial epoch. It would be well here to note an error in the illustration intended to show the vicinity of the "Second find," i. e. Little Falls, Minnesota (page 4). The figure instead is a reproduction of a sketch map of the region of St. Anthony falls, which are about 100 miles south of Little Falls. Aside from the doubtfulness of other evidences of paleolithic man in the United States, recently subjected to close scrutiny by Mr. W. H. Holmes, Mr. J. Crawford has shown (AM. GEOLOGIST, Vol. X, p. 160) that the human footprints in the volcanic tufa of Nicaragua are probably of even historic date, and that Dr. Earl Flint's observations were quite incorrect.

Of the Mound Builders the author has made a long and thorough study. He comes at first to the conclusion that they were not the ancestors of the modern Indians, or if they were that their works are so distinctive that they should be entirely separated from them in such an investigation. Where the remains of both are found in the same region they can be distinguished.

As to the Mound Builders proper they are divided by the author into several classes, and into different epochs distinguishable by varying structures, these being the result of natural adaptation to physical surroundings, rather than of age, or stage of progress. The peculiarities which distinguish the works of the true Mound Builders from the works of more recent inhabitants of the region, "arise from their being exclusively earthworks, and, first, their solidity; second, their massiveness; and third, their peculiar forms." The author makes eight geographical divisions of the Mound Builders, and points out severally their characters. In this, however, he evidently blends the Mound Builders with the historic Indians, assigning to them the same peculiarities and structures as mark the Indians that are known to have occupied the same

regions. Indeed, he deduces the presumed traits of the former from the well known traits of the latter, and does not make it clear in what respects the two dynasties differ from each other, yet he maintains that "there was a Mound Builders' age in this country, and that it is as distinctive as was the neolithic age in Europe". The neolithic age in America he considers to have been distinctively the Mound Builders' age. All prehistoric structures and mining, whether of copper, salt, steatite, mica, pipestone and oil wells, all workshops and stone cairns, walled towns, roadways and shell heaps were of Neolithic Mound Builders, who had a more varied and advanced culture than the Cliff Dwellers. They "followed hard on to the paleolithic people," but may have been separated from them by a conjectural age occupied by the Mastodon and Mammoth, or the Mastodon's age. The author is inclined to regard this (latter) age as linked closely with the Mound Builders, and for this he relies on sundry effigies and carved pipes that have the forms of the Mastodon. The elephant pipe of the Davenport Academy of Sciences has now sufficient confirmatory later discoveries to support it, but the *tablets* containing apparently Hebrew characters are thought to have originated from the Mormons who once dwelt along the Mississippi bluffs in Illinois.

The Mound Builders knew the Mastodon and they seem to have extended also to the time of the Buffalo, for the bones of both, or at least their effigies, are well known in connection with their structures. They were sun-worshipers, and the symbols of their religion are seen in the pyramid, the square and the circle which prevail. Their foes surrounded them and they built defenses. These foes were the ancestors of the red Indians. The "stone-grave races," which occupied central Tennessee, are regarded as a division of the Mound Builders. They survived to near the beginning of history, when they seem to have been expelled by some hostile tribes allied to the red Indians, who preempted their sites.

In the discussion of the migrations of the Mound Builders the author shows their very close alliance, and almost an identity with some of the early Indian tribes, that is, while stating the evidence of such migrations he draws it wholly from what is known of Indian tradition concerning themselves, and of statements from early historians. The author, however, considers it absurd to conclude that the Indians, for instance the Cherokees or the Dakotas, were the Mound Builders or were descended from them. Yet he gives, in the chapter on the "pyramidal mounds," the most conclusive evidence that De Soto saw the actual Mound Builders, in the form of Indians, inhabiting these walled towns, and putting to their various uses the different structures of the villages. Through the volume, at least in its earlier chapters, are scattered frequent assertions that the Mound Builders were a distinct race, maintaining a distinct dynasty, but driven out by a hostile inroad of less cultured tribes from the north or northeast. There is, however, a progressive modification of this idea, apparently the result of continued research by the author. It is due, perhaps, to the method of partial pub-

lication, as the *American Antiquarian*, which has from time to time contained much of the contents of this volume, put into printed shape the steps of the investigation, that some contradictions and some repetitions are apparent on comparing the various "papers." We come, then, in the chapter devoted to "Mound Builders and Indian relics," to a direct statement like the following:

"The Mound Builders changed to the Indian merely by contact with the white man (p. 273). * * * We maintain that the Mound Builder was a better specimen of the Indian than the native Indian is himself (p. 276)."

Yet while admitting the probable conversion of the Mound Builders to the Indian, the author sustains the propriety of a distinction between them. The Indian has degenerated from the partial civilization of the Mound Builders, while the Mound builder maintained some traces of a civilization still higher, suggesting an origin from some Old World races who in historical records are called civilized.

In an appendix Mr. Peet mentions the recent evidences that some of the tokens considered to show paleolithic men are unreliable. The interest of the reader increases toward the end of the volume, *pari passu* with the approach of the author to sound conclusions and to the consideration of live topics.

The volume is clumsily put together, as a literary structure, and as a specimen of typography. Also much or most of the matter is old and familiar. Still the author is to be congratulated on the several new ideas which he brings forward, and especially on the skill with which he adjusts the Mound Builders with the Indians, and his final conclusion that generically they are the same people.

It is to be regretted that he makes no mention of Lapham's important work on the earthworks of Wisconsin, for Lapham was the first scientist to announce the very conclusion to which the author finally arrives as to the identity of the Mound Builders and the Indians, and in that he stood alone for many years.

On the Continuity of the Paleolithic and Neolithic Periods. By JNO. ALLEN BROWN, F. G. S. (Journal of the Anthropological Institute of Great Britain and Ireland, vol. XXII, pp. 66-95, with four plates: November, 1892). The author's collections of stone implements have been chiefly near Eastbourne in Sussex, on the south coast of England in a district of high chalk hills with many ravines. The nodules of flint in the chalk furnished early man with abundant material for his work, and in many places the valleys and slopes of the hills are literally strewn with flakes and broken refuse from the manufacture of implements, mingled also with naturally fractured flints. Instead of the somewhat indefinite two-fold classification of the stages of progress in stone-working as paleolithic and neolithic, the author recognizes four stages, which he thinks to have been a continuous series. In analogy with the great eras of geologic time, he gives the following names to these stages of advancing human skill and culture: 1. Eolithic, represented by roughly hewn pebbles and nodules, showing work with a thick ochreous

patina, found on the plateaus of the chalk and other districts in beds unconnected with the present valley drainage. 2. Paleolithic, represented by coarsely flaked implements from the higher river drift of the present valleys, and by others of similar forms found in the oldest breccia deposit of limestone caves. 3. Mesolithic, characterized by more skillfully flaked implements, which appear, by their forms and often by the deposits containing them, to be intermediate and transitional, bridging the interval from the preceding to the next stage. 4. Neolithic, with implements of polished or delicately flaked stone. In the northern parts of Great Britain, and in Denmark and Scandinavia, comprising the countries covered by the European ice-sheet, the only traces of stone-working prehistoric men belong to this latest neolithic stage, showing, as was pointed out many years ago by Prof. James Geikie, that the more ancient stages of human progress in Europe were past before the end of the Ice age.

An Introduction to the Study of Mammals, Living and Extinct. BY WILLIAM HENRY FLOWER, Director of the Natural History Department, British Museum, and RICHARD LYDEKKER. London, 1891, pp. xvi, 763, with 357 figures in the text. This is a well arranged, interestingly written, and finely illustrated volume, indispensable to the zoologist and scarcely less to the geologist and paleontologist, since it notes under each genus its representation, if any, by fossil species, while for many of the orders their probable phylogeny or evolution is traced. Of the Simiidæ or true anthropoid apes of the eastern hemisphere, which structurally and in intelligence make the nearest approach to man, the earliest and only fossil species known is the extinct Dryopithecus of the Middle Miocene in France, pronounced by Gaudry to be the most generalized member of the family. The senior author's investigations of the varieties of the human species refer them to three types: 1. Ethiopian, Negroid, or Melanian, black. 2. Mongolian, or Xanthous, yellow or brownish. 3. Caucasian (a "misleading" term), white, but in some branches quite black. The aboriginal American peoples are regarded as a division under the Mongolian type, and the Malayan, Papuan, Australian, and Maori races are attributed to intermingling of the three types, chiefly of the first and second. The poverty of our geologic record is impressively exemplified by the entire lack of "evidence of the anatomical characters of man as he lived on the earth during the time when the most striking racial characteristics were being developed during the long ante-historic period in which the Negro, the Mongolian, and the Caucasian were being gradually fashioned into their respective types." Among the higher Anthropoidea man alone has been able to migrate to the western hemisphere from his place of origin, which was doubtless with the Simiidæ in the tropical zone of the Old World. His migration was apparently at a high northern latitude, where the severity of the climate debarred the passage of the apes and may very probably have made that of men impossible until after they attained the art of making warm clothing. The antiquity of our race in America, however, shown by geologic discoveries of stone implements, is accepted as almost equal with that yet proved for men in the old world, extending back in each hemisphere to the

Glacial period and therefore by necessary inference to some earlier time, either preglacial or interglacial, when the absence of the ice-sheets permitted migration.

The Geological and Natural History Survey of Minnesota, Twentieth Annual Report, for the year 1891. N. H. WINCHELL, State Geologist, Minneapolis, 1893, pp. 344. In this volume, besides the summary statement of the progress of the survey and records of additions to its museum and library, the state geologist discusses the structure and origin of the crystalline rocks of northern Minnesota; U.S. Grant presents notes of field observations on certain granitic areas in the northeastern part of the state, along the Kawishiwi river and in the neighborhood of Snowbank, Kekequabic, and Saganaga lakes, illustrated by a map plate and several figures in the text. H.V. Winchell and A. C. Lawson contribute the papers next reviewed in these pages; and Benjamin W. Thomas and Prof. Hamilton L. Smith write of fresh water diatomaceæ in an interglacial peat bed of Blue Earth County in southern Minnesota, giving a list of one hundred species, all of which, excepting one or two, are now found living in the great lakes of the St. Lawrence or in their tributaries. The peat occurs between deposits of till, being overlain by a thickness of twenty to thirty feet. In the till, both below and above the peat, careful examination reveals no diatoms, but only foraminifera, radiolaria, and other marine microscopic organisms, which were derived from Cretaceous beds eroded by the ice-sheet.

Professor Winchell defines the principal rock terranes of the region northwest of Lake Superior as follows, in descending order:

1. The Nipigon or Keweenawan series of alternating fragmental and eruptive beds, which south of Lake Superior are overlain by the St. Croix sandstone.

2. The upper part of the Animikie series, comprising thin-bedded slates, silicious and actinolitic schists, magnetitic jaspers, and quartzytes, interbedded with sheets of eruptive rocks and of tufaceous sediments.

3. Irruptive gabbro, bearing large quantities of titaniferous magnetite, and sometimes enclosing considerable masses of the next older quartzyte strata. Intimately associated with the gabbro are also acidic irruptives, as red felsytes, quartz porphyries, and reddish granites.

4. Basal Animikie beds of Pewabic quartzyte, associated with iron ores and cherts, including the important iron deposits of the Mesabi range. This formation also encloses sheets of volcanic outflows and tuffs, and is often conglomeritic with debris from the underlying Archæan rocks.

All the foregoing are grouped together by Prof. Winchell as the Taconic system, which is divided from the Archæan by unconformity and a great interval of erosion. The three members of the Archæan group or fundamental crystalline complex are together, like the four of the Taconic, regarded as a grand unit in their origin and history.

5. The Keewatin volcanic formation, consisting mainly of eruptive rocks and a great thickness of tuffs with more or less evidence of aqueous sedimentation. These rocks are mostly graywackes, sericitic schists, agglomerates, conglomerates, and very fine-grained serpentinous schists.

6. The Vermilion series of mica schists and hornblende schists, more fully and generally crystalline than the preceding, but of similar origin.

7. Laurentian gneiss, often conformable with the Vermilion schists, from which it then is distinguished by a gradual downward increase of feldspathic and silicious ingredients. More frequently, however, these lower members of the Archæan complex are divided by a zone of disturbance, upheaval, and brecciation, with dikes and laccolite masses of the granitic Laurentian extending upward into the Vermilion series, or where this is wanting, into the less crystalline Keewatin schists. Evidently some of the Laurentian rocks were fluid or plastic after or during the time when the overlying Vermilion and Keewatin members of the Archæan complex attained nearly their present lithologic condition.

The Mesabi Iron Range. By HORACE V. WINCHELL, pp. 111-180, with 6 plates and 9 figures in the text. (Twentieth Annual Report, Geol. Survey of Minnesota.) The latest discovered and probably the richest of the numerous iron-producing belts in the region of lake Superior is the Mesabi iron range, in northeastern Minnesota, lying 15 to 20 miles south of the Vermilion iron range, where extensive mines of hard hematite have been very successfully worked during the past ten years. The chief ore of the Mesabi mines is soft hematite, easily excavated with only the pick and shovel and capable of being rapidly worked with a steam shovel, lying in nearly flat deposits which have a variable thickness up to 100 feet, being usually overlain only by 10 to 50 feet of glacial drift. Its earliest discovery in sufficient deposits for profitable mining was in November, 1890, at the Mountain Iron mine, and the next at the Biwabik mine in August, 1891. Since that time about twenty other merchantable deposits of this ore have been found and nearly a hundred miles of railroads have been built for its transportation to Duluth, to be shipped thence to Cleveland, where coal is cheaply furnished for smelting furnaces. Contracts have been made by the companies now developing these mines for the yearly shipment of 1,500,000 tons of ore, equal to about a sixth of the present lake Superior product. The cost of mining and loading the ore on cars is estimated to average 25 cents per ton, and of its delivery in Cleveland about $3, leaving a profit of a dollar per ton at the present Cleveland prices for ores of the Bessemer grade here mined.

The stratigraphic relationship and conditions of origin of the Mesabi iron ores are well described and discussed by Mr. Winchell, who attributes the original deposition of the interbanded jasper and hematite beds to oceanic sedimentation, both chemical and mechanical, but the present concentration of the ores as soft hematite deposits of great thickness and purity is referred to the action of infiltrating water while this area has been a land surface undergoing slow subaërial erosion. Silicious portions of the iron-bearing strata have been dissolved and replaced by the ore, which preserves the bedding planes, joints, and even differences in texture, of the original layers of jasper, chert, taconyte, and slate. The underlying portion of the Pewabic quartyzte appears to have received the greater part of the removed silica, becoming an impervious floor beneath the ore deposits. The beds usually dip 10° to 20° S. or S.E.,

and the width of outcrop of the ore belt is usually a half mile to one mile and probably nowhere exceeds two miles, while the known length of outcrop in Minnesota is about 145 miles, from the Mississippi river at Pokegama falls east-northeast to the Canadian boundary at the west end of Gunflint lake.

Sketch of the Coastal Topography of the North Side of Lake Superior with special reference to the abandoned Strands of Lake Warren. By ANDREW C. LAWSON, pp. 181-289, with 6 plates and 15 figures in the text. (Twentieth Annual Report, Geol. Survey of Minnesota.) An abstract of this paper, as given in the announcements of the Ottawa meeting of the Geological Society, has already appeared in this volume of the GEOLOGIST (March, pp. 177, 178), with citations of the opinions held on this subject by G. K. Gilbert and Warren Upham, who differ from Dr. Lawson and ascribe the formerly higher levels of lake Superior, as of the other Laurentian lakes, to the barrier of the waning ice-sheet. Continuous levelling along any of the shore lines of this ruggedly hilly and forest-covered coast of lake Superior has been impracticable, but the altitudes of the old shores have been determined by levelling at forty-eight places from the west end of the lake at Duluth to its southeastern angle and outlet at the Sault Ste. Marie. In the vicinity of Duluth the highest shore is 535 feet above lake Superior, or 1137 feet above the sea; and the highest shore anywhere discovered is on Mt. Josephine, near Grand Portage, about 140 miles east-northeast from Duluth, having an altitude of 607 feet above the lake. At Jackfish bay, again about 140 miles farther east-northeast, and somewhat east from the middle of the north coast, nineteen shore lines were identified, the highest being 418 feet above the lake; and at Sault Ste. Marie the highest one of eight shores observed is at 414 feet. In total, at the forty-eight localities where Dr. Lawson examined this northern and eastern shore of the lake, he recognizes, as he believes, thirty-three distinct former lake levels shown by deltas, terraces, and beach ridges, their average vertical distance apart being therefore about 18 feet. Where the highest beach was found, on Mt. Josephine, seven of these old shores are discernible, being in descending order at 607, 587, 509, 313, 226, 43, and 20 feet above the lake. Where the greatest number for any single locality was found, at Jackfish bay, their hights are 418, 391, 367, 317, 259, 238, 228, 176, 158, 136, 128, 119, 103, 85, 57, 46, 33, 19, and 10 feet; and at the Sault Ste. Marie, 414, 365, 311, 224, 208, 174, 150, and 49 feet.

Dr. Lawson thinks that this ancient lake, which was named Lake Warren by Prof. J.W. Spencer, was not held in by the retreating ice-sheet but by land barriers, the country on the south and east having been relatively higher than now, and that the differential subsidence of the land there and contemporaneous uplifting of the country about Hudson bay went forward without disturbance of the horizontality of the old shore lines north and east of lake Superior. On the west, however, it has been ascertained by Upham for the area of the glacial lake Agassiz, in the basin of the Red river and of lake Winnipeg, that it experienced a differential uplift increasing about one foot to the mile from south to north during the departure of the ice-sheet; and on the east Leverett has

well shown that the beaches of lake Warren south of lake Erie were contemporaneous with the accumulation of adjacent moraines (Am. Jour. Sci., April, 1892); while the basin of lake Iroquois, the glacial expansion of lake Ontario, according to levelling by Gilbert and Spencer, has been uplifted like that of lake Agassiz, but with a greater northward ascent of the old Iroquois beach, amounting to five feet per mile for fifty miles from Rome to near Watertown, N.Y. It seems therefore improbable that these recent epeirogenic movements on each side failed to extend across the area of lake Superior. Under the assumption that they were thus continuous, the highest shores at Duluth and on Mt. Josephine seem readily referable to an ice-dammed lake in the western part of the Superior basin outflowing in a channel eroded across the divide between the Bois Brulé and St. Croix rivers (Geol. of Minn., vol. ii, p. 642), from which there is an ascent of about 140 feet in a distance of 120 miles northeast to the 607 feet shore terrace; but the 418 and 414 feet shores at Jackfish bay and Sault Ste. Marie, with all found at lower elevations, would belong to the more extended stage of lake Warren when it outflowed to the Mississippi across the low divide at Chicago, about 595 feet above the sea, whence the former lake level now has an ascent of 421 feet in about 350 miles to the highest shore at the Sault.

The American Meteorological Journal, published now at Boston by Ginn & Company, was started at Ann Arbor, by Prof. M.W. Harrington, who is now the chief of the Weather Bureau, at Washington, and who remains as a "contributing editor." The journal is a valuable one for all physicists who study the climatology of the country, and we can commend it for being ably edited and as an excellent repository of current discussions of the principles and progress of meteorology.

Geologic Atlas of the United States. The following sheets have been issued as geological maps, dated Oct., 1892, Chattanooga, Kingston, and Hawley; also the Sacramento sheet, dated Jan., 1893, and the Lassen Peak sheet as "preliminary edition of 1892." Each sheet area is represented by four sheets, one giving the topography, which is expressed by contour lines at intervals of 100 feet, one the areal geology, one the economical geology, and the fourth, structure sections or other illustrations. These four sheets, which are colored according to the conventions of the survey, are accompanied by four or five other sheets or pages of descriptive text, and the whole are loosely embraced in a folded case of heavy manilla paper, on the front or title-page of which is an "index map" showing at a glance the position of the mapped area with respect to the rest of the country.

These five sheets are the first completed product of the United States Geological Survey. When the whole country shall have been represented in this style, the United States will have a geological and general descriptive atlas of which no American will be ashamed.

Sur la constitution des dépôts quaternaires en Russie et leurs relations aux trouvailles résultant de l'activité de l'homme préhistorique. By S. NIKITIN. 34 pp., in Report of the International Congress of Archæologists, Moscow, 1892. At the close of this paper, the distinguished

author, writing from his point of view as a geologist, gives the following summary of his conclusions relating to the earliest traces of man in Russia and his relationship to the Glacial period.

1. The subdivision of the age of stone into the Paleolithic and Neolithic epochs should be defended for European Russia, because it coincides with the geologic division into Pleistocene and Modern, based on paleontologic data.

2. Study of the glacial deposits of Finland and western Russia furnishes no proof of two distinct epochs of glaciation and an interglacial epoch; all the facts can be explained by the oscillation of the ice-sheet during its retreat, which was gradual but irregular.

3. Even if one accepts the Swedish and German theory of the subdivision of the Glacial period in two epochs, the second glaciation can be affirmed only in the northwestern area, in a limited part of the Baltic region of Finland, and of the province of Olonetz.

4. The remaining part of Russia subjected to glaciation has only drift corresponding to the first glacial epoch of Swedish geologists.

5. At the time of maximum glaciation, the greater part of Russia presented the aspect of a desert of ice, comparable with that of Greenland; it bore no drift on its surface, and had no elevation above the ice sheet, where vegetation could be preserved.

6. The time corresponding to the interglacial epoch and to that of the second glaciation of Swedish geologists was probably for the greater part of Russia the epoch of formation of the ancient lake deposits, loess, and highest river terraces, containing bones of the mammoth and other extinct mammals, which abounded while Scandinavia and Finland were still covered by the ice-sheet.

7. Agreeing with the composition and origin of its Quaternary deposits, Russia may be subdivided in a series of districts characterized by variations in the fauna of the immense Russian plain during the Quaternary era and the formation of its superficial deposits.

8. In the second half of the Glacial or Pleistocene period, the mammoth and other large animals lived in great number in southern and eastern Russia. As fast as the ice-sheet retreated, these animals advanced to the north and northwest; toward the end of the Pleistocene they reached Finland for a very little time, and then disappeared soon throughout Russia, but probably lingered latest in its northeast part and in western Siberia.

9. Man lived contemporaneously with the mammoth during the second half of the Glacial period along the boundary of the glaciation, possessing much industrial skill and using fire, but producing only implements of flaked flint. Following the recession of the ice-sheet man advanced toward the north and northwest, reaching Finland and the Baltic region after the end of the glaciation and after the disappearance of the mammoth; but he then had attained the more advanced culture of the Neolithic epoch, making both flaked and polished stone implements, pottery, etc.

10. European Russia presents no traces of man's existence during the first half of the Pleistocene or any earlier time.

Geology and mineral resources of Kansas, with a geological and contour map of the state. ROBERT HAY. World's Fair edition, octavo, pp. 66. (From the eighth biennial report of the State Board of Agriculture, 1891-92.) Topeka, 1893.

This pamphlet amounts to a compendium of the geology of the state, including its economic relations. The topographical map is very generalized, the whole state being embraced in two octavo pages.

The range of formations is from the Subcarboniferous (Keokuk) to the present, omitting, however, the Jurassic and Triassic. The Comanche Peak beds and the Trinity sands of Texas are found to extend into Kansas, the two having a thickness of 150 feet. These and the "Permian" cover a horizon of beds whose age has been the subject of much difference of opinion. The "red beds," here called Permian, have been put in the Triassic by most geologists, and the Trinity sands are claimed as Jurassic by Mr. Marcou, who also identified the Comanche Peak beds as Neocomian. Mr. Cragin has applied locally the name "Cheyenne sandstone" to the formation called Trinity sands by Mr. Hay, although Mr. Cragin was latterly disposed to admit that the Cheyenne sandstone represents the northward extension of the Trinity.

After a brief description of the various formations in their typical outcrops, or as discovered by deep wells, the economic products of each are enumerated, and their value to the material development of the state is presented. The important mineral products of the state are lead and zinc, coal, lignite, rock gas, salt, gypsum, cement, lime, building stone, clay, vitrified brick, mineral waters, and the surface soil. The work will serve, as doubtless it was designed, as a convenient hand-book of the natural resources of the state, for general distribution at the World's Fair at Chicago.

The Eocene and Oligocene beds of the Paris basin, accompanied by a geological map. GEORGE F. HARRIS and HENRY W. BURROWS. 8vo, 129 pp. (Read before the Geologists' Association, London, Apr. 3, 1891.)

The Paris basin is the typical area for the Tertiary terranes. There Cuvier and Brongniart did their classic work, and thither Lyell repaired for comparison of his English studies with those of his French confreres. De Blainville, P. Gervais, Pictet and latterly Gaudry followed Cuvier in giving to science a restoration of the extinct vertebrates. Such names as Deshayes, Lamarck, Lambert, De Boury, Defiance and latterly Cossmann are forever linked with its molluscoidea. Its stratigraphic succession has been dissected, compared and established, first by the original explorers, Cuvier and Brongniart, and subsequently corrected and more minutely described by many savants. Foreign students have a vast amount of geological literature to consult should they desire to know the Paris basin thoroughly.

It has been the task of Messrs. Harris and Burrows to furnish an epitomized English re-description of the whole, in the light of the present condition of knowledge, eliminating, correcting, and supplying new material. The nomenclature is revised in accordance with accepted rules. Typical field sections of the various members of the series are reproduced, with directions how to find them. Tables show the names and

stratigraphic distribution of all the species. The work really affords a useful condensed manual of the actual Paris basin according to the most recent views without attempting to make correlations with English localities. It would be a reasonable sequel to this work if the authors should continue their study so as to warrant them in indicating the English and, if possible, the American parallels of the strata of the Paris basin.

Notes on the Correlation table of British and continental Tertiary strata. GEORGE F. HARRIS. (Extracted from Newton's "Systematic list of the Frederick E. Edwards collection in the British Museum," London, 1891.) The table itself is "An approximate correlation of the Tertiary beds of Europe"—an outgrowth or accompaniment of the work above reviewed. The "Notes" call attention to and reproduce various other classifications, viz.: that of Mayer-Eymar in 1884; those of Dollfus of 1875, 1877 and 1889; Gosselet in 1888; Prestwich in 1888; and of Stremm, Meig, and Bertrand & Kilian in 1888.

A revision of the British fossil Cainozoic Echinoidea. J. WALTER GREGORY. (Proceedings of the Geologists' Association, Vol. XII, Nos. 1 and 2, July, 1891.)

The author brings to bear on his results a study of all available collections, public and private. Under each species he gives "the present resting place of its type specimen," and adds a general account of the collections in the various museums. He adds five foreign species to the English fauna, describes eight new species, two of them belonging to genera new to the British area, discards six English species as synonyms, and suggests, (1) that the London clay echinoids are dwarfed subtropical forms, (2) that the lower Eocene echinoids are more allied to the lower than the upper chalk, (3) that some connection must have been established between the British sea and that of the Mediterranean basin in the middle, and perhaps upper, Eocenes, and (4) that the most striking feature in the Crag echinoid fauna is that it is of twofold origin; since in addition to the ordinary North Atlantic forms it contains a series of genera found in the Mexican and Antillean regions, or of species most closely allied to these, which testifies of some direct connection of warm, shallow sea, and probably points to the past existence of at least a ridge or chain of islands across the southern part of the North Atlantic.

CORRESPONDENCE.

THE OLDER DRIFT IN THE DELAWARE VALLEY. In the March number of the GEOLOGIST professor A. A. Wright makes some statements concerning the older drift of the Delaware valley to which I should like to respond briefly, going back to the time his original paper on the subject was presented, as well as one by professor G. F. Wright bearing on the same question.

This was at Rochester, in August, 1892. On that occasion I was much surprised to learn that professor G. F. Wright (whose paper was

presented before professor A. A. Wright's) had interpreted my report (in the annual report of New Jersey for 1891) as saying that the ice went south to Trenton and Morristown during the ice epoch antedating the last. I promptly indicated that I had never intended to convey this impression. In my report, I referred to various localities where drift which I regarded as glacial occurs outside the moraine. After mentioning these localities, I stated my opinion that the drift there found was glacial, and that it antedated the moraine epoch by a long interval of time. I then went on to mention other localities where glaciated stones and drift occur, not specifying that it was glacial drift. I have never at any time felt sure that it was such, and on the very page (107) where the localities of glaciated stone are mentioned, I took pains to specify that glaciated stones are no proof that the deposits containing them are directly glacial. Nevertheless, since the report was interpreted as I did not intend it to be, I am ready to concede that I am at fault, for it is a writer's business to write so that he cannot be misunderstood. Of ambiguity, therefore, I am doubtless guilty.

But when the correction was publicly made, as it was at Rochester in August, 1892, immediately after professor G. F. Wright had presented his paper, it would seem that the correction might have been accepted. But in the March GEOLOGIST professor A. A. Wright says: "Since it was pointed out that these different southernmost deposits are all within 100 feet above tide and have doubtless been transported by water and floating ice from the glaciated area, the author quoted has, as I understand, relinquished any claim that he may seem to have made that an ice-sheet ever extended further south than High Bridge and Pattenburg, N. J." It would be difficult to relinquish a view which I never held. Since I only "seem to have made" the claim, professor Wright doubtless knew of my disclaimer, which was made before the presentation of his paper. It is, therefore, not clear why he should "understand" that I had relinquished the claim after the *publication* of his paper, which followed the *reading* by an interval of some months. I was perfectly well aware of the altitude at which the deposits in question occur from the beginning, since I had been on the ground with the topographic maps in hand. Furthermore, the fact that the deposits are low has no decisive significance as bearing on their origin.

Professor Wright also quotes me as referring to "a subdued terminal moraine eastward from Trenton," when my words are "The topography in this region east of Trenton is very much like that of a subdued terminal moraine." My statement concerning the topography is strictly true. The reader must judge whether the quotation of professor Wright fairly represents what I say. More than one writer in the past has referred to the moraine-like topography of certain parts of Florida. It is to be hoped that they may be spared the fate of being quoted as saying that there are moraines there.

So far as professor Wright's further statements are concerned I only wish to add that, if I have seen them correctly, the "deposits between the moraine and the southern border of the glaciated area" are not "essentially the same as that of the moraine itself and of the deposits north

of the moraine;" and that further, so far as I am familiar with the region, there are not "many places" in New Jersey where there are such accumulations of bowlders that "the moraine could well be brought further south than it is plotted, without doing violence to the facts." That there are "abundant accumulations of bowlders and till" south of the moraine is certain; but that they are such as to make it possible to bring the moraine further south is not true of any single locality with which I am familiar. Since, however, I have not seen the moraine and drift outside it at every point, I will not attempt to say that professor Wright's statement is necessarily wrong. But the criterion for the position of the moraine is something else than "such abundant accumulations of bowlders and till." R. D. SALISBURY.

REMARKS ON MR. ANDREW C. LAWSON'S *Sketch of the coastal topography of the north side of Lake Superior with special reference to the abandoned strands of Lake Warren.* (20th Ann. Report Geol. Survey, Minnesota.)

P. 274.—*Terrace bay*—"Recognized as early as 1847" (by Logan—Report Geol. Sur., Canada). 1st. Logan's terraces are three miles below the *Petits Ecrits, sixty miles* east from Terrace bay of Lawson. 2d. Logan saw them in *1846*, not 1847, and described them in his *Report of Progress for the year 1846-7*, page 35.

The same terraces are beautifully represented in Agassiz's Lake Superior, *frontispiece*, and described at p. 66, as *Rivière à la Chienne* (Dog river of Lawson).

In Agassiz's Lake Superior, there are represented other terraces at Toad river (Riviere aux Crapauds), between Montreal river and Michipicoten (page 54). I suppose Mr. Lawson calls it Sand river? J. M.

DON PEDRO DE SALTERAIN Y LEGUARRA, Head Geologist of the Spanish West Indies, died at Havana, the 20th of February last. Born at Trun on the river Bidasoa, Bicaye, the 12th of March, 1835. Salterain was appointed mining engineer in 1858, by the Spanish government, and had charge of the celebrated copper mines of the Rio Tinto, near Huelva. Then he was transferred to the famous quicksilver mines of Almaden, and three years after he was sent to Cuba, as chief engineer of the Oriental district of mines. He became inspector-general of mines, and had charge of all the geological and mining surveys of the islands of Cuba and Porto Rico. His paper: "Breve reseña de la Mineria de la isla de Cuba," 1883, gives a good description of all the mines existing in Cuba. His geological works, which are the most important, are: first, a description of the "Juridiciones de la Habana y Guanabacoa" with an excellent geological map of the environs of Havana, Madrid, 1880; and second, his complete geological map of Cuba, scale 1:2,000,000, 1869-83, published with Don Manuel Fernandes de Castro, Director of the Geological map of Spain, in the *Boletin de la Comision del Mapa Geologico de España*, Madrid, 1884. Besides Salterain wrote several papers on the earthquakes of Cuba. He was a modest and most exact observer.

J. M.

SIGNOR FELICE GIORDANO, Director of the Geological Survey of Italy, died 16th of July, 1892, at Vallombrosa, a summer resort in the Tuscany Apennines, where he was spending his vacation for his health, much impaired two years previously by a very severe attack of influenza. He fell into a deep ravine, and was found dead. Giordano, in his journey round the world, 1872-74, visited extensively the United States and Mexico, stopping first in California, and then crossing over by the Great Salt lake, to the Mississippi valley. He passed one week in September, 1874, at Cambridge, with his old friend Jules Marcou. At New York Mr. S. F. Emmons showed him all the works and collections made by the survey directed by Clarence King, and ever since Giordano kept an excellent remembrance of Mr. Emmons, asking often about him and his new works.

Extremely modest, very learned, Giordano published from 1864 to 1892 forty-five papers on geology, mining industry, and his voyages to Borneo and in Southern Asia. With his friend Quintino Sella, he made the first successful ascent of the Matterhorn (Monte Cervino), from the Italian side of the Alps, in September, 1868, only two days after Tyndall's ascent from the Valais side.

Giordano was Chief Inspector of the Mining Engineer corps of Italy, and the head of the corps; he was also the first Director of the "Service de la Carte Géologique" at Rome. He has been succeeded by Signor Niccolo Pellati, as Director and chief of the "Real Corpo delle Miniere."

J. M.

J. J. COLLENOT, a well known French geologist and paleontologist of Semur, Côte-d'or, died during the fall of 1892. His very large and fine collection of Jurassic fossils, more especially of the Lias, attracted to Semur many geologists, among them the great paleontologist Alcide D'Orbigny, who took Semur (*Sinemuria* in Latin) for his typical locality of the Lower Lias, called by him *Sinemurian*. Many of the Liassic fossils bear the name of *Collenotii*, in honor of Monsieur Collenot, who published a remarkable geological description of the vicinity of Semur, near Dijon.

Collenot was a successful public notary, who retired from public life with a handsome competency, which allowed him to pursue his geological researches. His collection was thrown open to every observer, and he received in the most friendly and hospitable way all geologists, more especially foreigners, for he used to say: "Farther distance from which a geologist comes to see me, the more I must try to please him." Besides loading him with fine fossil specimens, he treated his visitors to the best of Burgundy wines. Professor Alpheus Hyatt, of Cambridge, always remembers and speaks with enthusiasm of the cordial reception and treatment of Collenot, when he visited him in the seventies.

J. M.

PERSONAL AND SCIENTIFIC NEWS.

THE MISSOURI GEOLOGICAL SURVEY has just passed through the hands of the 37th general assembly, with a considerably reduced appropriation. Twenty thousand dollars were allotted for the maintenance of the survey during the next two years, including printing. The cause of the reduction was a recent diminution in the rate of taxation. The non-partizan character of the organization of the survey also militated against it in the hands of the dominant party.

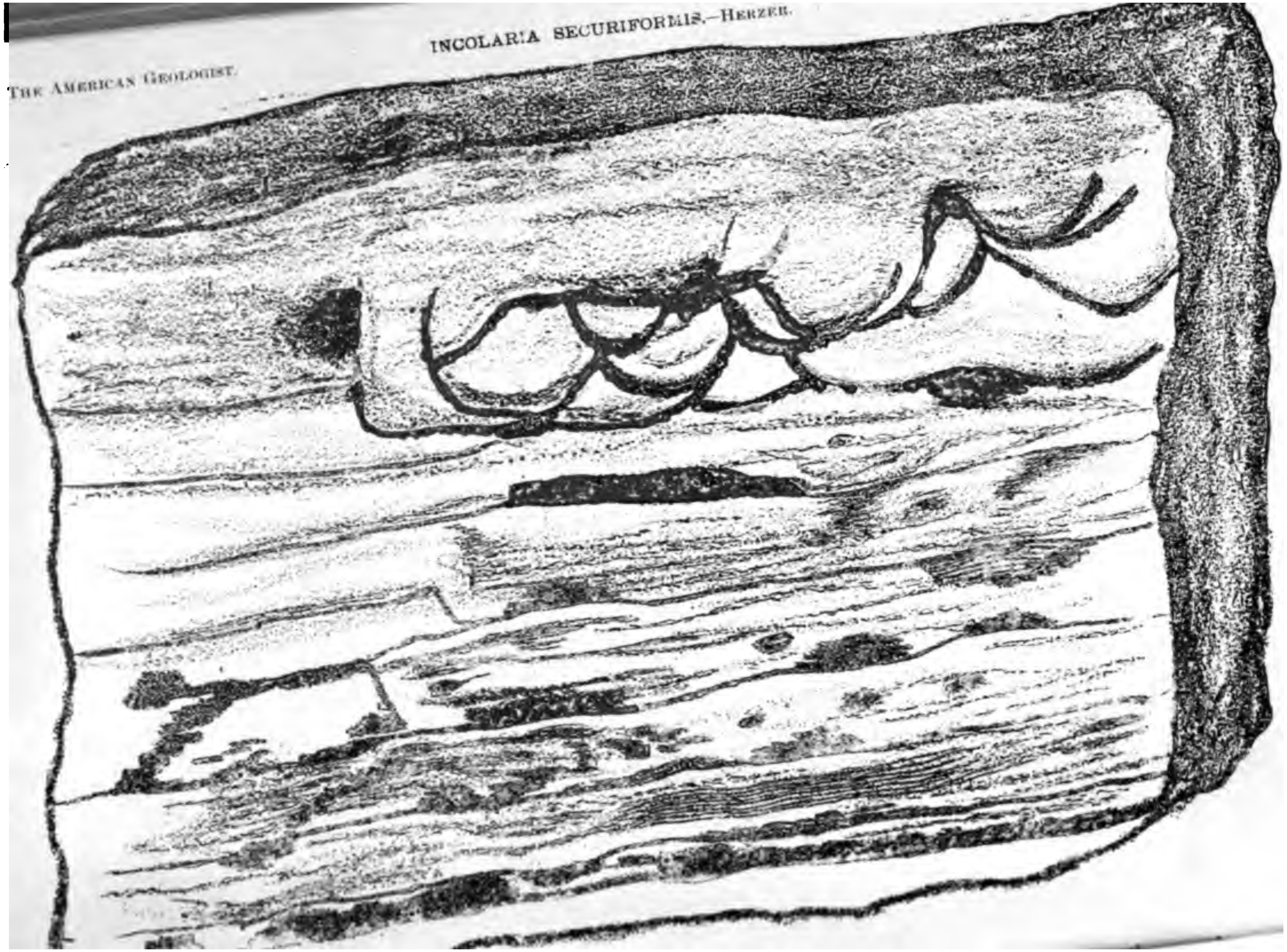
THE MINNESOTA GEOLOGICAL SURVEY received a cash appropriation of ten thousand dollars at the hands of the late legislature. This is to be used exclusive of printing, and, united with the proceeds of the Salt Spring fund, will sustain the survey during the next two years.

THERE HAS BEEN AN ORDER issued by the Michigan Board of Geological Survey to remove the headquarters from Houghton to Lansing. All the employés of the survey were dismissed May 1st. There is a strong sentiment against the union of the Survey with the Mining School, in the directorship, and that seems to be the cause of the action taken. The citizens of the northern peninsula, however, insist on retaining the Survey headquarters at Houghton, near the school but not directly connected with it.

THE GOVERNOR OF GEORGIA has appointed W. S. Yates, of the Smithsonian Institution, Washington, State Geologist of Georgia, in place of Dr. J. W. Spencer.

APATITE IN NORBOTTEN, NORWAY.—In the "Neues Jahrbuch für Mineralogie," 1893, page 38, G. Loesstrand gives the result of his observations on the occurrence of apatite in this district. After mentioning the researches of Brögger on the scapolitic gabbros of Norway, and the fact that they are very rich in apatite, Loesstrand goes on to say that although the olivine-gabbro is richest in apatite, yet its occurrence seems to be restricted to districts where the original formation contained a good deal of apatite, and that this mineral did not seem to be so much in the gabbro itself as where it came in contact with hornblende slates. The gabbro contained most apatite where hornblende slates appeared in intimate association with it. When the gabbro was permeated with stringers of pegmatite, apatite was very likely present, and when these pegmatite lodes contained a good deal of plagioclase, the chances of finding apatite were still further increased. As usual accompaniments of the apatite he mentions titanium minerals, hornblende, enstatite, mica, scapolite, epidote, and tourmaline. One of the lodes traversing the hornblende slates, gneiss and gabbro carries rose-red quartz and salite at one point, and farther away hornblende, plagioclase, quartz and tourmaline, and what is of special interest, crystals of scapolite 7 in. long and 1.18 in. thick.

INCOLARIA SECURIFORMIS.—HERZER.



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A NEW FUNGUS FROM THE COAL MEASURES.

By H. HERZER, Berea, O.

PLATE IX.

Genus INCOLARIA, n. gen.

Incolaria securiformis (n. sp.).

Evidences of the presence of acotyledonous plants of soft cellular tissue, such as Fungi, during the Carboniferous period, gradually multiply. It is not the abundance of the same species that we find, but representatives of various tribes of this family, individualizing their genera or species. The present genus had hitherto not been recognized by geological researches. However meager these finds are, it is a gratifying fact that *so* much of the flora of remote ages is disclosed to us.

Our genus was of the peculiarity *to colonize in fissures of bark, filling them throughout their extent along the principal axis, accommodating itself to the irregular forms of the opening and sending laterally, from the length of its stem, numerous vertical, broad, rounded, securiform, thin mycelia,* 1½ to 2 *inches in diameter, three or four of them overlapping each other irregularly at different distances, ten of them thus presenting themselves.*

The Fungus here described is similar in habitat to Lesquereux's Rhizomorpha sigillariæ. It was found under the bark of a Sigillaria imbedded in the Zoar limestone, Tuscarawas Co., O., and its peculiar undulating outlines contrasting with the linear fluting of the Sigil-

laria arrested my attention at once. Parts of carbonized bark are still attached to the Sigillaria and between the mycelia of the fungus thin layers of coal are observable, showing that an effort was made by the resinous bark to exclude the intruder in coating it with its substance, until the fungus prevailed, separating the bark from the decaying substratum, and in falling was buried in a calcareous sea; hence the impossibility of preservation of its cellular arrangement or filamentous texture. The fine calcareous mud has filled its soft and loose tissue, calcifying it thoroughly, leaving only its unmistakable form and habitat. The Sigillaria, retaining some of its carbonaceous matter with faint traces of cicatrices, is thinly covered with fine fragmentary crinoids and shells, as is also its parasite. The limestone slab, bearing on its surface these forms, contains the common fossils of that time.

The substance of the fungus above described is of dirty yellowish color and of chalky softness, quite different from the hard, dark-bluish limestone. It is without any carbonaceous matter, fully concurring with another most remarkable fungus of a quite different genus from coal No. 5, Tuscarawas Co., O., the substance of which is essentially the same. The latter is a most remarkable preservation with cellular arrangement and sporiferous tubes, and is astounding in size and generic character. It will be described in another paper.

RECENT CHANGES IN THE MUIR GLACIER.

By S. PRENTISS BALDWIN, Cleveland, Ohio.

A comparison of the measurements of motion of the Muir glacier made by Prof. G. F. Wright, in 1886, with those made by Prof. H. F. Reid, in 1890, brings out strongly the dependence of a glacier upon the minor and perhaps local changes of climate, and the rapidity with which the effects appear.

In 1886 Prof. Wright reported a rate of sixty-five to seventy feet a day in the most rapidly moving portions;* but in 1890 Prof. Reid found no higher rate than a little over seven feet a day.† The bare statement of this apparent discrepancy, without any explanation, very naturally led, at first, to the belief that one set of measurements must be incorrect, and as

*Am. Jour. Sci., Jan., 1887; Ice Age in North America, 1889, p. 50.
†National Geographic Magazine, vol. IV, p. 44.

Prof. Wright's observations were confessedly made with less care than Prof. Reid's his results were discredited. For that reason it seems necessary, before explaining the causes of difference, to turn attention for a few moments to the measurements themselves. This is made more necessary by the strange position taken by a recent writer, who, assuming that a glacier always moves at the same rate, and assuming that the measurements were taken in the same place, and in similar manner, has overlooked the statement made by Mr. Cushing, that "undoubtedly the ice was in more rapid motion at the time of Prof. Wright's visit,"* and overlooked the other literature of the subject, to attribute the entire discrepancy to inaccuracy of Prof. Wright's observations.†

When Forbes began his observations on the Mer de Glace, in 1842, he made the following table of the results given by previous observers, and after perusal of the table he declared that no confidence whatever could be placed in their records.

Bakewell	540 feet per year.
De la Beche	600 " " "
Shirwell	300 " " "
Rendu	365 " " "
Saussure's ladder	375 " " "

But Rendu pointed out to him the reason for the differences, and in 1845 Forbes seems to have accepted Rendu's point of view. Prof. Tyndall says in his "Glaciers of the Alps:"‡ "The numbers in the above table differ widely, and it is perhaps natural to conclude that such discordant results are of no value, but the fact really is that *every one of them may be perfectly correct.*" This old lesson is perhaps not yet quite out of date.

The reasons for the discrepancy may well be divided into three classes: first, the probable error; second, difference in manner or locality of measurement; and third, actual difference of motion of the glacier.

1. PROBABLE ERROR.

A. When Prof. Wright's results were announced six years ago, comparatively little was known of the motion of the glaciers in Greenland, or of other large glaciers, and the contrast of the Muir

*AMERICAN GEOLOGIST, Oct., 1891, p.216.

†W J McGee, Am. Anthropologist, Jan., 1893, p. 89, and Science, Dec. 2, 1892, p. 317.

‡Page 305.

motion with the few feet a day of the Alpine glaciers raised, at once, the feeling that such motion was impossible. But, at the present day, I would hesitate to take time to show the inherent possibility and probability of such motion, except that the work done by Danish geologists in measuring the rates of many Greenland glaciers seems to have escaped the notice of a recent writer in Science, who alludes to Prof. Wright's measurements as not "in harmony with all other observations."*

Mr. Upham has kindly sent me the following notes from an article on "The Inland Ice of Greenland," in the Scottish Geographical Magazine:† "The velocities of the same glacier at different seasons have also been partly determined. During this work, fluctuations have been discovered, of which the nature and cause remain completely unknown........The measurements of twenty-five or thirty glaciers ending in deep fiords........prove that the middle portions of all these glaciers, at the period of quickest motion, have an average velocity of 51 feet in twenty-four hours, or a little over two feet per hour........The true home of icebergs is the coast between 68½° and 75° north latitude, which contains all the large ice-fiords on the western side that are thoroughly known. The most southerly, the Jacobshaven fiord, has been most minutely explored, and the observations extend over many years. The depth of the glacier in the center probably amounts to considerably over 1,000 feet. The breadth is 14,000 feet, and the middle part moves in July 63½ feet in 24 hours (Helland, 1875). About 4,000 feet nearer the side, in March and April (Hammer, 1880) the speed was 33 to 51½ feet. The declivity of the whole glacier was only ½°....The examination of the next section, from 69¾° to 72½°, was the work of Steenstrup......The Torsukatak glacier is 25,000 feet broad, and the velocity at some distance from the center is 16 to 25 feet in 24 hours (according to Helland, 29,000 feet broad; velocity in the center, 30 to 32 feet)." Karajat glacier, 19,000 to 22,000 feet wide, velocity 22 to 38 feet. Itivdliarsuk glacier, 17,500 feet broad, velocity 46 feet in April, 21 to 28 feet in May.

Between 72½° and 75°, in the Bay of Augpadlartok......"the branch of the inland ice, which there descends into the sea, has

*W J McGee, Science, Dec. 2, 1892, p. 317.

†Vol. v, pp. 18-28, Jan., 1889, translated by W.A. Taylor from Dr. H. Rink in "Zeitschrift der Gesellschaft für Erdkunde zu Berlin, vol. 23, No. 5."

the highest rate of velocity ever observed in a glacier, namely, 100 feet in 24 hours, or over 4 feet an hour. A measurement at about the same point gave only 34 feet per day in April."

In another place* we find that Prof. Steenstrup writes to Prof. Joseph Prestwich: "Mr. Care Ryder has measured a progress or a flow of the great glaciers, ninety-nine feet per diem or in twenty-four hours in summer, and thirty to thirty-five feet in twenty-four hours during winter months."

The great size of the Muir glacier may well lead one to expect a high rate of motion, while its form, and the small outlet through which its several hundred square miles of ice must be forced, would point to even a higher rate. The measurements of 1886† were taken with a sextant, reading by vernier to ten seconds, from a base line, which was very carefully measured several times. They were taken every four days, and every reading was made independently by Prof. Wright and the writer, and in case of disagreement each read the angle again. In no case did the two readings differ by more than twenty seconds, and seldom more than ten seconds, a variance which would not cause more probable error, in the greater motions, than a few inches or a foot. The central portions of the glacier were so broken that it was impossible to cross or to set flags near the center, so measurements were taken to certain well defined pinnacles of ice.

From the fact that Prof. Reid's party were unable to recognize from day to day any definite ice pinnacles from their base line, it has been suggested that Prof. Wright may have mistaken one point for another. Professor Wright's base line was at the same level as the ice surface, and the faster moving points were white seracs of unusual form, seen against the dark background of the mountain beyond, while several of the nearer points were black with moraine matter and were seen against the white ice beyond.

Prof. Reid's base line was several hundred feet above the level of the ice, and he, of course, saw each point projected against its own color. I well remember that we could not recognize our points when we were above their level. The identification was complete, for to this day I remember the points well enough to

*Nature, Dec. 29, 1887.

†For full account see Am.Jour.Sci.,Jan., 1887, p. 8, and The Ice Age in North America, p. 50.

sketch them so that Prof. Wright could recognize each one and call it by name. Prof. I. C. Russell writes me that in his attempt, in 1890, to measure the motion of the Seward glacier, his base line was on the same level as the boulders and pinnacles to which he sighted, and the identification was complete.

In fact, a re-examination of the measurements shows no room for error more than the probable error necessary to any observations under such conditions. What this is cannot be exactly ascertained. Prof. Reid gives as the possible error in his observations two feet, or a ratio of 2:7. Prof. Wright's measurements were made with a less accurate instrument, but, on the other hand, the ratio of probable error decreases as the distance measured is greater, so that 2:7 would seem too large. That ratio would be twenty feet, but the probable error can hardly be more than ten feet, with a possible error of fifteen.

B. Prof. Reid, finding it impossible to identify seracs from his base line, undertook to set a line of flags across, and measured their motion with a theodolite, from two points on opposite sides of the glacier.*

Prof. Reid made only two observations on his most rapidly moving flags, on July 21st and four days later, but on the flags nearer the sides he was able to make several measurements. He gives two feet as the amount of possible error on his central flags. Thus it would seem that only a very small part of the discrepancy can be explained by inaccuracy of observation.

2. Difference of Method or Locality.

A. Prof. Reid, speaking of his inability to find the direction of motion from his observations, says: "This, however, was unimportant, for the direction is given by the moraines, which were about at right angles to the line E-K." This seems not quite accurate, for examination of the map shows that the moraines of the eastern half are crowded by the strong stream from the north more and more toward the east side, as they near the front of the glacier, without anywhere turning toward that side.

According to Prof. Reid's map, the moraine from Nunatak I, in moving two miles down the glacier, is forced three-fourths of a mile to the side. The moraines from Nunataks H and I, in moving one and a half miles down, move five-eighths of a mile toward

*Nat. Geog. Magazine, vol. IV, p. 43.

each other, while the moraine from H is forced one mile toward E in a distance of two miles. The moraine from Granite cañon in moving down three miles is forced sidewise more than one and a half miles. From this it is evident that at any point of the moraine the direction of motion is not the direction indicated by the moraine at that point, but varies from that course 15° to 45° to the east. So the moraines at the line of sight indicate a motion at right angles to that line, while they are really pushed sidewise toward E rapidly enough to increase Prof. Reid's most rapid rate by one-fifth, or more than a foot, and to become an important feature in higher rates.

B. In regard to the localities of the measurements, it must be noted that the ice-front was 3,000 feet farther back in 1890 than in 1886, but all the measurements were taken within 6,000 feet of where the ice-front of 1886 stood.

In 1890 the part of the glacier where Prof. Wright's points 1, 2, and 3 had been, was gone; the part which contained 4 and 5 disappeared while Prof. Reid's party were camped there; and the localities of 6, 7 and 8 had become nearly the land front of the ice. Prof. Wright's point 5 was farthest back, but that was at least 1,200 feet in front of Prof. Reid's line of measurement. Prof. Wright's point 2 was 3,700 feet in front of that line. It should be stated that these points are not accurately located on Prof. Wright's sketch map in the "Ice Age in North America."

Examination of the glaciers of the Alps has shown that very considerable local differences of rate are caused by a small variation in descent or form of the bed. The Muir glacier must be subject also to more or less local influence from the side glaciers entering it, but it would hardly seem that these causes could account for more than small differences. They may have been responsible for a part of the seeming discrepancy between the measurements of the two seasons.

C. Prof. Reid, finding it impossible to cross the glacier was unable to set flags over a distance of fifteen hundred feet in the most crevassed and most rapidly moving portion of the glacier. That his measurements thus fail to give the highest rate then existing on the glacier, Prof. Wright has pointed out in his last book* and this undoubtedly explains a part of the discrepancy, but

*Man and the Glacial Period, 1892, p. 47; also AMERICAN GEOLOGIST, Dec., 1892, p. 397.

Mr. Cushing has recently well shown that it is quite incompetent to explain the whole difference between eight or ten feet and sixty-five feet.*

3. ACTUAL DIFFERENCE OF MOTION OF THE GLACIER.

A. Mr. Cushing first pointed out the connection between the reduced rate of motion found in 1890 and the remarkable changes of condition which had taken place since 1886,† and Mr. Upham has quite recently attributed the apparent discrepancy in part to that same cause,‡ but the extent of these changes and of their effect seems not to have been fully shown.

So much evidence of recent recession of the glacier has been given in all late accounts, and Mr. Cushing has so clearly presented that evidence to the readers of this magazine§ that little comment is necessary. Suffice it to say that the glacier has been retreating very rapidly for the last fifty or one hundred years, leaving long stretches of moraine upon which no soil has formed and no plant grows, although the region is very favorable to vegetation. The eastern half of the glacier seems to have very little motion, and to receive very little re-enforcement from winter snows. In fact, it is entirely cut off from its sources of supply, and retreats down its valleys instead of up. Where we should expect névé we find a lake and the melting end of the glacier. Mr. Cushing says: "Hence the ice lying in Granite cañon presents the same features as that in Main valley. The ice is inert. It has no feeders. It has disappeared from the upper portions of the valley while yet lying in considerable force in the lower portion. It diminishes in altitude toward the head of the cañon, the highest point in the vicinity lying nearly three miles south of the entrance." Again: "If there is the present slow flow of ice in Main valley already spoken of, a flow in both directions from the highest point of the ice, there must be a corresponding slow flow of the ice back into Granite cañon." That this remarkable diminution is quite recent is evident from the moraines which extend from Granite

*AMERICAN GEOLOGIST, April, 1893, pp. 276-8.

†AMERICAN GEOLOGIST, Oct., 1891, p. 216.

‡"Comparison of Pleistocene and Present Ice-sheets," Ottawa meeting of G. S. A., Dec. 29, 1892.

See also "Muir Glacier," S. P. Baldwin, Scientific American, April 9, 1891, p. 227, and "Review of Prof. Reid's Studies of the Muir Glacier," in AMERICAN GEOLOGIST, Nov., 1892, p. 326.

§AMERICAN GEOLOGIST, Oct., 1891, pages 210-216.

cañon and Main valley to the ice-front, although the upper portions now move back toward their parent ledges.

The most noticeable change was the recession of the ice-front three thousand feet during the four years from 1886 to 1890. The position of the ice-front depends mainly on the rate of motion of the ice and on the rate at which the front melts back or breaks off. The aerial melting is evidently a small factor in the retreat of the water front, and conditions under water are subject to but very slight variations, as of temperature or tides. It follows, therefore, that this recession can only be due to reduced rate of motion.

In 1886 the ice-front was from 250 to 300 feet high above the water, and the general surface where the measurements were taken was a little over 400 feet above the water. In 1890 the hight of ice-front varied from 126 feet to 210 feet,* averaging 170 feet. The difference is much greater than at first appears, for this level of 170 feet was back at the point where Prof. Wright's furthest measurements were taken, that is, where the ice stood over four hundred feet above the water in 1886. Since the slope of the glacier from the front was nearly the same in both periods, we must conclude that *the entire surface of the glacier was two hundred and thirty feet higher in 1886.*

The moving force of the glacier is that part which is above the sea level, for it is evident that the ice below sea level is restrained from originating any tendency to motion outward by the presence of the waters of the bay. This moving force, then, in 1886, was two and one-third times as great as in 1890, or, if we drop one-third to allow for error, *it was at least twice as great*, while the mass to be moved, if we suppose the glacier to be about one thousand feet thick, was only about one-fifth greater. Just what the effect may be of such a difference in vertical front, is difficult to say, but it is certain that any cause affecting the entire surface of the glacier must have a much intensified effect, when its results are condensed into the small space allowed by the narrow opening into Muir Inlet.

B. On account of the general low condition and the position of the ice-front in 1890, the western branch seems to have added little, if any, pressure toward the outlet, while in 1886 it pushed directly toward and into the outlet.

C. The glacier in 1890 was discharged through an outlet fifteen

*See map by Prof. Reid, Nat. Geog. Mag., vol. IV., p. 55.

hundred feet wider than in 1886. It is evident that when a mass so great as that of the Muir glacier is forced through a very narrow outlet, the rate of motion through that opening must be very great, while any widening of the outlet will largely decrease the rate.

D. The form of the ice front of 1886 seems to show that the glacier was in an actual state of *advance* during that season. When a glacier, which has both land and water front, remains in a state of equilibrium, or of retreat, the water front retreats more rapidly than the land front, and forms an embayment. *A projection of the water front beyond the land wings indicates positive advance.*

Prof. Reid has set forth very clearly the conditions holding at the ends of tide-water glaciers.* He shows that the waste by melting above the water surface is unimportant, but that the ice in contact with the water is melted more rapidly than that exposed to the air. Add to this waste the loss by breakage, and it is plain that the water front wastes more rapidly than a land front. In tide-water glaciers the breakage is the more rapid because of the tides, particularly in Glacier bay, where the usual tides are about fifteen feet and the spring tides as much as twenty-three feet. The period of most numerous ice falls in 1886, was the time of spring tides. I think Prof. Reid observed the same phenomenon.

This embayed form is illustrated in most glaciers of to-day which have water fronts, as the Greenland glaciers. The Tracy glacier of Bowdoin bay shows it very plainly, as pictured by Lieutenant Peary. The Marjelen lake encroached upon the Aletsch glacier while it stood at high level.

But the moraines of the Glacial period show this more plainly, since we know that the ice was in retreat or equilibrium while they were formed. A great moraine which crosses New Hampshire and Vermont turns northward near Burlington and passes through Milton, Vt., to Beekmantown and Altona, N. Y., showing an embayment of ten to fifteen miles. Mr. Upham writes me: "As you inquire about the glacial lake Agassiz, whether its expanse of water washing the ice-front caused it to be indented by an embayment, as made known by the courses of the terminal moraines which come to (and in very low and changed form run across) the lake area, I have to reply, Yes, very definitely so, for the eighth, ninth, tenth and eleventh, or respectively the Fergus Falls, Leaf Hills, Itasca, and Mesabi moraines. The extent of the indenta-

*Nat. Geog. Mag., vol. IV, pp. 47-49.

tion of the ice boundary was fifty to one hundred miles back from the lobed extensions of the ice-sheet on each side."*

The slowly changing land wings are only affected by long continued causes, while the water front easily vacillates with any slight change of conditions. The Muir glacier affords a striking illustration. In 1886 the water front extended about fifteen hundred feet beyond the land wings, indicating advance. In 1890 it was in a very low condition and at least fifteen hundred feet back of the land wings, as beautifully shown in photograph taken by Prof. Reid.† In 1891 Miss Scidmore found the front still in embayed form, but it is a significant fact that the season of 1892, like 1886, was a season of real advance, as shown both by the form of water-front and by the fact that the ice had actually advanced nearly to the position occupied in 1886.

It should be noted that a small angle of ice, in the center, projecting, even in the embayed form, beyond the rest of the water front, is no indication of the general condition of the glacier, but only of the more rapid motion in the center.

E. While the width of outlet from the great amphitheater of the Muir glacier only slightly exceeds the width of many Alpine glaciers, the area of ice to be discharged through this outlet is much greater than the area of any Alpine glacier.

The remarkable changes in the glacier are evidently due to this concentration of effects, and do not demand unusual changes of climate. What the difference of meteorological conditions may have been it is impossible to say, on account of the fragmentary character of the observations taken in Alaska, and their distance from Glacier bay.

TUCUMCARI MOUNTAIN.

By W. F. Cummins, Austin, Tex.

Tucumcari mountain is situated in New Mexico on the south side of the Canadian river about fifty miles west of the west line of Texas. It is one of a number of buttes in that vicinity, remnants of the old table land.

In 1853, professor Marcou passed through that part of the country and afterwards published a map of the line traveled over through eastern New Mexico.

*See also "Glacial Lakes in Canada," Bulletin, G. S. A., vol. II, p. 273.
†Nat. Geog. Mag., vol. IV, p. 47.

In 1891, I traveled the same route followed by professor Marcou, and when I reached the locality found that the mountain marked Big Tucumcari on Marcou's map is now called Mount Revuelto, and his Little Tucumcari is called Big Tucumcari, and the name Little Tucumcari is now applied to the small mountain between his Big and Little Tucumcari.

The question very naturally arose as to which butte was really entitled to the name Big Tucumcari, the Cerro de Tucumcari of the first travelers. After looking into the matter as closely as my facilities admitted, I concluded that from some cause unknown to me, Marcou was in error, and so stated in my report and made my map to correspond with the facts as I understood them. I did not know Prof. Marcou's reasons for applying the names as he had, and did not assign any reason why I thought a mistake had been made by him.

In the AMERICAN GEOLOGIST, Dec., 1892, in a review of my report, Prof. Marcou contends for the correctness of his designation, saying, "The map of Mr. Cummins in the Third Ann. Rep. Geol. Survey of Texas, is at variance with the three first maps published and according to the right of priority cannot be used for geographical names of the Tucumcari mesa."

It is due to Prof. Marcou and no less to myself for me to make a statement of the reasons why I believed him to be mistaken in the application of the names.

A word in regard to priority as I understand it: Had Prof. Marcou and party been the first explorers through the country and had they found a number of buttes and designated any one of them by a certain name and given its position on a map so that it could be identified by later travelers, he then could have claimed priority. But if he went into a country where others had been before him and where a peculiar butte had previously been observed and named and where such a minute description of it had been given as to enable others who visited the same locality later to identify it by the description, then the claim for priority would not be available for any map he might publish that did not agree with the previous designation. It was upon the very ground of priority that I thought Prof. Marcou was wrong in his designation.

Prof. Marcou can maintain his right to priority to the name "Pyramid mount" for one of the buttes in that vicinity because he gave that name to a hitherto unnamed hill. But Prof. Marcou

lays no claim to the name Tucumcari, but affirms that he applied the name to a butte that had been so designated by others by that name and was well known at the time of this visit. His claim for priority has no force unless he can show that he followed what had already been done by others.

That he did not follow what others had done before him I think can be shown, and that he did not so follow his predecessors was my reason for making my map different from his and suggesting the mistake.

The first thing to consider then is, the amount of information in existence at the time of Prof. Marcou's visit, and the precision with which mount Tucumcari had been described.

The first mention I have been able to find of Tucumcari is in "Commerce of the Prairies," written by Josiah Gregg.*

In that report it is said that he left Van Buren, Ark., on the 21st of April, 1839, with an expedition for Santa Fe, New Mexico. The party traveled up the north side of the Canadian river. When about sixty miles east of the narrows of the Canadian on the 20th of June, he left his wagons and with three Comancheros (Mexican Comanche traders) as guides started ahead for Santa Fe, while the wagons were to follow more leisurely. They followed a cart trail up the north side of the Canadian to the narrows where the point of a very high plateau projected so abruptly against the river as to render a passage with wagons very difficult if not impossible. He says: "Upon expressing my fears that our wagons would not be able to pass the Angustura in safety my comrades informed me that there was an excellent route of which no previous mention had been made, passing near the Cerro de Tucumcari, a round mound visible to the southward."

Gregg sent one of the Mexicans back to the wagons with instructions directing the party to take the route by Tucumcari which they did and reached the Pecos river at Anton Chico.

In 1840 a party known as the Santa Fe expedition, left Austin, Texas, bound for Santa Fe, New Mexico.

The expedition divided into two parties at the head of Big Wichita river. One party was to travel ahead as rapidly as possible while the other was to follow at a more leisurely gait. The first party traveled northwestward and struck the Canadian at the Arroya de Truxillo and followed up the river to the road from

*Com. Prairies, Vol. II, p. 59.

Independence, Mo., to Santa Fe which led them to Anton Chico. Some Mexicans were sent back as guides to the other party which was led by the way of Tucumcari and along the road afterwards pursued by emigrants along the Canadian to New Mexico. (Pacific R. R. Reports, Vol. XI, p. 39, Supplement.)

In 1849 Lieut. J. H. Simpson traveled through the country. Keeping along and over the bluffs bordering the south side of the Canadian river as far as Rocky Dell creek, they gradually diverged southwest from the river to the Tucumcari hills. Continuing west they crossed the Gallinas some ten miles above the mouth and struck the Pecos river at Anton Chico.

Of that part of the trip Lieut. Simpson makes the following statement.

Page 13.—"The next object of interest to the traveler will be Cerro de Tucumcari, or Tucumcari hill, which he will begin to see a mile or two after crossing Emigrant creek. In relation to this hill I extract the following from my journal:

"Camp 55, June 16.—The route to-day has been interesting, on account of its developing the accuracy of my calculations in regard to our geographical position. Soon after taking up the line of march, a small, faint, cloud-like appearance of small but growing extent, exhibited itself, bearing magnetically nearly west. A few miles further on, this appearance gave way to a well defined, truncated cone. Proceeding still farther on, and in proportion as we progressed, a domelike appearance gradually unfolded itself, till at length, when we had almost reached our present camp [page 14], an assemblage appeared which did not fail to strike many of us as being a most excellent representation of the dome of the Capitol at Washington. This object which we have gazed at nearly all day with the greatest interest, we take to be the Cerro de Tucumcari; and if so it very satisfactorily accords with the geographical position which my observations, in connection with the map of lieutenant Abert, give. There have been some among the emigrants who have been disposed to be skeptical as to the efficiency of the watch —as they call the chronometer—in determining our position; but, as Capt. Marcy remarked to me this afternoon, 'they must now begin to have more faith in its reliability.' The guide we have with us, though acquainted with the country on the north side of the Canadian (west of the Antelope hills) has known nothing of it on this side since we left the vicinity of Choutau's."*

And again:

"Camp 57, June 18.—This day has been one of interest to us, for two

*Report of Exploration and Survey of route from Fort Smith, Arkansas, to Santa Fe, New Mexico, made in 1849 by First Lieut. James H. Simpson, Corps of Topographic Engineers. (House of Representatives Ex. Doc. No. 45, 31st Cong., 1st Session.)

reasons. A number of Comanches—the first we have met—have been into camp and we have been assured by them that the hill which we have been regarding for the past three days is indeed Cerro de Tucumcari. My calculations then have proved correct; and when there has been so much to mislead—perpetrated doubtlessly unwittingly by those who have preceded us—in regard to the distance to Santa Fe, it is a gratification to find that the information I have given from time to time, in direct opposition to more flattering statements, has become corroborated.

"And again from my journal of the same day, in reference to my visit to the hill:

"Finding that our road to-day was shunning the hill which we are now assured is the Cerro de Tucumcari of Gregg, when seven miles from our last camp I started for it in company with an escort of three dragoons, to approach and ascend it. Startling on our way some eleven or twelve deer and half a dozen hares, and passing over a poor soil covered with the Mexican soap plant, we reached it after a two hours or eight miles ride. Telling one of the dragoons to time his horse around the base, and giving the charge of the others to the other dragoon, I took the third with me up the hill. After a most laborious ascent, of which some fifty feet were nearly vertical, we reached at last its summit. On every side was an unobstructed view. To the west and south lay a confused mass of irregular hills, with here and there a well defined conical one to characterize the scene. Far behind to the west lay a range of mountains or hills, and more conspicuous than the rest a high peak which I thought might possibly be a glimpse of the Rocky mountains. [It proved not, however, to be these mountains.]

"To the south some eight miles distant, I could see with my reconnoitering glass the serrated tents of our little command, quietly reposing on a timbered affluent of the Canadian, to which they had resorted since I had left them. To the southeast and east lay the famous 'Llano Estacado' of the Mexicans. To the northeast and north lay a limitless extent of broken undulating prairie, no signs of the Canadian being apparent. Pacing the top of the mound I found it to be 230 yards by 370 in area; and by a measurement of the slope of the hill, and roughly reducing it to an angle of 45 degrees, I made its hight to be over 700. The circumference of its base to our surprise I found to be nearly six miles, it having taken a horse two hours, less eight minutes, to walk around it. It was most refreshing to both the dragoon and myself in [page 15] our descent, when we were almost ready to die with thirst, to find a couple of small springs whence we drank copiously.'"

It will be seen very readily from these quotations that there was a well known route through the region at the time of Prof. Marcou's visit and one of the buttes was known as the Cerro de Tucumcari.

The description of this butte is given by Lieut. Simpson with

such minuteness that there is no mistaking to which of them he gave the name Cerro de Tucumcari, and that the description he gives cannot be applied to the Big Tucumcari of Marcou and can only be applied to the one designated by me as Big Tucumcari, for the following reasons:

First.—From the distance at which Tucumcari can be seen from the eastward along the route traveled by Lieut. Simpson, being the same route traveled by Marcou. Lieut. Simpson says of it.: "a mile or two after crossing Emigrant creek." I traveled along the same road and saw it from the top of the plains eight miles east of the Texas state line.

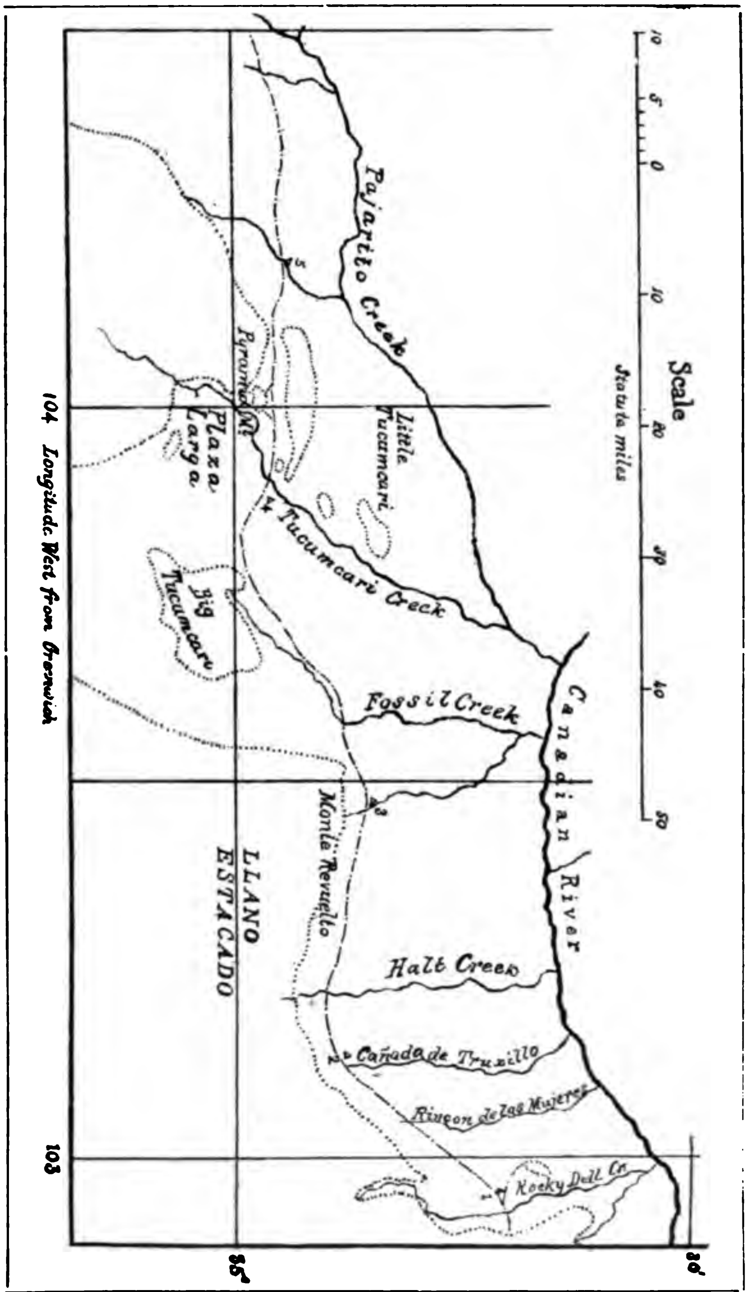
The adjoining plate is an exact copy of Prof. Marcou's map upon which is shown the line of travel. The dotted line shows the northern escarpment of the Llano Estacado, which rises to the hight of four or five hundred feet above the plain along which the line of travel is marked. The map shows the relative position of the hills under discussion.

Now let the reader take this copy of Marcou's map and with a ruler draw a line touching the extreme northern limit of Marcou's Big Tucumcari, and his Mont Revuelto, and he will see that a straight line protracted will not again touch the line of travel after having crossed it at the base of Marcou's Revuelto. From anywhere east of the Revuelto along the line of travel, according to his map, his Big Tucumcari cannot be seen. Revuelto of Marcou is a point of the Staked Plains and is as high as his Big Tucumcari. Of Revuelto he says: "It is the most prominent peak and the best landmark of the area and it is not easy to make a mistake with." Being so prominent it of course hid from view from the east his Big Tucumcari.

Second.—The form it presents when first seen in the distance. Gregg mentioned it as a round mound plainly visible from the north. Simpson mentioned it as a "well defined, truncated cone," and as they got nearer it resembled the dome of the capitol at Washington.

That is exactly the appearance of the butte called Big Tucumcari by me, but the other presents no such appearence when viewed from any direction, and especially from the east as it cannot be seen very far in that direction.

Third.—The hight of the summit. Lieut. Simpson estimates the hight of the hill above the base at 700 feet. By repeated



FAC-SIMILE OF MARCOU'S MAP.

measurement with an aneroid barometer we found the hight of the summit to be 620 feet above the base and 4720 feet above the sea level; while Marcou's Mont Revuelto, the most prominent peak, is 4520 above the sea level, making the hill I call Big Tucumcari 200 feet higher than all other peaks in that vicinity. This accounts for the fact that the one called Cerro de Tucumcari comes into sight before the others from different directions.

Fourth.—The situation the two hills occupy as to the old road. Simpson put it on the north side of the road. In the quotation from his journal he says: "To the south some eight miles distant, I could see with my reconnoitering glass the serrated tents of our little command, quietly reposing on a timbered affluent of the Canadian."

It will be seen by reference to the map that the Big Tucumcari of Marcou is on the south side of the old road, the road passing very near to its northern base.

Fifth.—From the position Cerro de Tucumcari occupies with reference to the other hills in the vicinity.

The Cerro de Tucumcari of Lieut. Simpson is the most northern hill in the vicinity. He says: "To the northeast and north lay a limitless extent of broken undulating prairie;" and again, "To the west and south lay a confused mass of irregular hills."

Sixth.—From the area of the base. The hill called Big Tucumcari by Marcou is irregular in outline, and the side on the north next to the road is nearly four miles in extent and is not less than ten miles in circumference.

Lieut. Simpson says of Cerro de Tucumcari: "The circumference of its base to our surprise I found to be nearly six miles, it having taken a horse two hours, less eight minutes, to walk around it."

Seventh.—From the size of the area of the summit. On the top of Prof. Marcou's Big Tucumcari there is not less than two square miles.

Lieut. Simpson says of the one he called Cerro de Tucumcari: "Pacing the top of the mound I found it to be 230 yards by 370 in area." We found it to be about the area given by Lieut. Simpson.

Eighth.—From the difference in position of Cerro de Tucumcari of Simpson and Big Tucumcari of Prof. Marcou as to the Llano Estacado. The hill called Big Tucumcari by Prof. Marcou

is the one farthest south and is only a few miles from the escarpment of the Llano Estacado. Lieut. Simpson says: "To the southeast and east lay the famous 'Llano Estacado' of the Mexicans." Had he been within a few miles of the Plains and they in full view on the south with no intervening hills he would certainly have mentioned them in that direction as well as to the southeast and east.

It is evident to me for the reasons assigned that the Big Tucumcari of Marcou is not the same as the Cerro de Tucumcari of Simpson, and that the one now known as Big Tucumcari by the inhabitants of the country and so marked on my map is the one described by Lieut. Simpson.

The name Revuelto, as applied to a hill in that vicinity, is not mentioned by any of the early travelers through the country prior to the visit of Prof. Marcou. The name is given by him to a point of the Staked Plains where the line of the escarpment turns almost at a right angle from a west to a south course. It is not an isolated peak as are the other buttes in the vicinity, and is only prominent on account of the turning of the line of escarpment so abruptly to the south. The hill called Big Tucumcari by Marcou is now called Revuelto by the inhabitants of that country.

The peculiar appearance of the Staked Plains at Monte Revuelto, described by Prof. Marcou* "as having a second gigantic step or grade called by the Mexicans Monte Revuelto," is also especially applicable to his Big Tucumcari. When it comes into sight at his camp No. 3 there is seen to be a second hill or step on the top of the other, sitting back some distance from the top of the first elevation.

NOTE ON AN AUGITE SODA-GRANITE FROM MINNESOTA.†

By ULYSSES SHERMAN GRANT, Minneapolis, Minn.

The object of this communication is to call attention to an interesting type of granite from the Pre-Cambrian rocks of northeastern Minnesota. It occurs on the shores of Kekequabic lake, which lies near the northern edge of Lake county and only a mile or two south of the International boundary. This granite has often been mentioned in the reports on this region, but it has

*Geol. N. A., p. 55.

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never been carefully studied microscopically and chemically. It is found in two facies, a granitic and a porphyritic, which seem to be rather distinct from each other in their field relations and in hand specimens, but in reality they are very closely related, undoubtedly forming parts of the same rock mass. The granitic facies occurs in a roughly oval area whose major axis (east and west) is about four miles, the minor axis being less than two. It has been described as a fine syenitic gneiss or granite* and as a pyroxene granite.† The porphyritic facies is confined to a number of small, isolated areas occurring irregularly in the clastic rocks.

The minerals composing the granite are feldspar (mostly anorthoclase), quartz and augite, with accessory hornblende, biotite, apatite and sphene. The structure of the rock is truly granitic, its description as a gneiss arising from the fact that it is sometimes broken into roughly parallel layers, but there are no structural or mineralogical differences between the layers. The granitic facies is of a dull pinkish color and of medium grain; the feldspar often shows a decided tendency to a more or less complete idiomorphic development. The prophyritic facies is of a gray color and has a very fine-grained—almost microgranitic—ground-mass composed of quartz and feldspar; in this ground-mass are imbedded numerous large and sharply outlined phenocrysts of feldspar and smaller ones of augite. The feldspar phenocrysts are sometimes arranged in roughly parallel lines, but this is never very pronounced.

On chemical analysis the two facies are found to agree very closely. A noticeable fact brought out by these analyses is that in both cases the proportion of soda is very much larger than that of potash. Using the term "soda-granite" as a true granite in which the soda is in excess of the potash, this rock would belong to the series of soda-granites, which, while reported from several localities in Europe, have as yet been rarely found in America. Such a rock has been described by W. S. Bayley from Pigeon point, Minnesota, on the north shore of lake Superior, in connection with a quartz-keratophyre.‡ The analyses of both

*N. H. Winchell, Geol. and Nat. Hist. Survey of Minn., 15th (1886) Ann. Rep., pp. 361-369; 16th (1887) Ann. Rep., pp. 100-108. A. Winchell, Ibid., 15th Ann. Rep., pp. 149-156.

†U. S. Grant, Ibid., 20th (1891) Ann. Rep., pp. 69-82.

‡A quartz-keratophyre from Pigeon Point and Irving's augite-syenites. Amer. Jour. Sci., (3) vol. 37, pp. 54-62, Jan., 1889.

facies of the rock under consideration and of three other soda-granites are as follows:

	I	II	III	IV	V
SiO_2	66.84	67.42	68.00	70.69	72.42
TiO_2	——	——	——	——	0.40
P_2O_5	tr	0.07	——	——	0.20
Al_2O_3	18.22	15.88	16.18	15.20	13.04
Fe_2O_3	2.27	1.37	3.68	3 76	0.68
FeO	0.20	1.14	0.65	——	2.47
MnO	——	tr	——	——	0.09
CaO	3.31	3.49	4.05	3.31	0.66
MgO	0.81	1.43	0.95	0.45	0.58
K_2O	2.80	2.65	2.04	2.31	4.97
Na_2O	5.14	6.42	4.32	4.69	3.44
H_2O	0.46	0.05	——	0.56	1.21
	100.05	99.92	100.49	101.07	100.37*

I is the granite from Kekequabic lake, Minnesota (No. 551G of the Minnesota Survey series); II is the prophyritic facies of the same (No. 86G); III is a soda-granite from Donegal, Ireland;† IV is the Aughrim (Ireland) soda-granite;‡ V is the rock from Pigeon Point, Minnesota.§ In comparison with the last three analyses given above and other published analyses of soda-granites‖ the rock here described is seen to be lower in the amount of silica and usually higher in soda than other granites of this series. The large proportion of soda finds expression in the composition of the augite as well as in that of the feldspar, as will be seen in the analyses given below.

The feldspars are mostly polysynthetically twinned and show the optical properties of plagioclase, but a considerable number in the granitic facies of the rock are untwinned and seem to be monoclinic in character. Zonal structure is quite common in the phenocrysts of the porphyritic facies. On separating a powder of a fresh specimen of the granitic facies (No. 551G) by means of Thoulet's solution, the larger proportion of the feldspar fell between 2.58 and 2.62, which would indicate that it was a mixture of the orthoclase and albite molecules, and the analysis of

*Including traces of Li_2O and Cl and 0.15 of BaO.

†S. Haughton, Q. J. G. S., v. 20, p. 269.

‡W. J. Sollas, Trans. Roy. Irish Acad., v. 29, pt. 14, p. 471.

§Amer. Jour. Sci.,(3) v. 37, p. 59.

‖ Cf. A. Gerhard, Neues Jahrbuch f. Min., Pet. u. Pal., 1887, II, pp. 267-275.

this feldspar, as here given, shows that it belongs to the anorthoclase series. It is to be noticed that the silica percentage

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	H_2O	Total
67.99	19.27	0.82	0.75	0.02	3.05	6.23	0.90	99.03

is larger than is required by the amount of soda, potash and lime present; this is probably due to the fact that a small amount of quartz was so intimately intergrown with the feldspar that the two could not be completely separated. This feldspar is then an anorthoclase with approximately the composition $Or_5 \, Ab_{14} \, An_1$. The specific gravity of several of the phenocrysts of the porphyritic facies of the rock was determined. It ranges from 2.59 to 2.60, which, together with analysis of the whole rock (II above), is sufficient proof of its being anorthoclase.

The quartz is found in comparatively small quantities, rarely amounting to more than one-quarter of the mass of the rock. It never occurs as phenocrysts in the porphyritic facies of the granite and in the granitic facies it was the last mineral to crystallize, occupying small areas between the feldspars, which are of larger sizes and frequently partially idiomorphic.

The augite is the most interesting mineral in the rock, as true granites in which this mineral is the chief ferromagnesian constituent are comparatively rare. It makes up from five to twenty per cent. of the whole rock and in the majority of sections is the only ferromagnesian mineral present. A few small flakes of biotite are found in some sections, and original hornblende occurs less frequently. In the porphyritic facies and in the freshest specimens of the granitic facies the augite is seen in its best development. It occurs in short, stout prisms bounded by the unit prism, ortho-pinacoid and clino-pinacoid; the terminal faces, with the exception of the basal plane, are not well developed, there being a tendency to the rounding off of the edges of the basal plane, but a clino-dome is sometimes noticeable. The color of the augite is green, although there are parts of some crystals which are colorless, and entirely colorless individuals are rarely seen. A slight pleochroism is to be noticed in some sections, $\mathfrak{a}$ and $\mathfrak{b}$ being green and hardly distinguishable from each other, while $\mathfrak{c}$ is a yellowish green. Zonal structure is rather common; in such cases the center is colorless or of lighter color than the outer layers. The colorless centers sometimes pass gradually into the colored rims, but usually the two are separated

by a distinct line. The outlines of these colorless cores are irregular and are usually not crystallographic planes. The green crystals and rims have a lower index of refraction, lower double refraction and a smaller extinction angle than the colorless variety. In a section of a zonal crystal cut parallel to the clinopinacoid the colorless interior has an extinction angle, measured against the cleavage, of 40 degrees in acute angle B, while the extinction angle of the green outer rim is about 25 degrees. From this it seems that the green crystals and rims contain more of the acmite molecule than the colorless ones. A very typical fresh specimen (No. 86 G) of the porphyritic granite was powdered and the augite separated and analyzed. This augite is fresh and unaltered and the powder, which fell at about a specific gravity of 3, is quite pure, as in this specimen of the rock the only minerals present were feldspar, quartz, augite and a few small fibers of secondary hornblende. The analysis is as follows:

SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O	Total
53.19	2.38	9.25	5.15	17.81	9.43	0.38	2.63	0.01	100.23

Assuming that this represents an isomorphous mixture of the diopside, heddenbergite, acmite and fassaite molecules, and calculating their relative proportions, we get approximately the result given below. In the considerable percentage of the acmite molecule this approaches in composition the augite of the more alkaline rocks, the eleolite syenites.

Diopside, Mg Ca Si_2O_6	47	per cent.
Heddenbergite, Ca Fe Si_2O_6	27	"
Acmite, Na $\ddot{F}e$ Si_2O_6	21	"
Fassaite, Mg Al_2 SiO_6	5	"

The augite is often seen altering to fine green hornblende needles, and sometimes the needles have been developed all through the rock mass. An attempt has been made to measure the angles occurring on some of the larger crystals of augite detached from the rock, but the faces gave such imperfect reflections that no reliable results could be obtained.

The original accessory minerals occur only in small amounts. Secondary hornblende is common and abundant in all the altered specimens of the granite, while original hornblende has been noticed in but three sections, and here it, together with the biotite, is as abundant as the augite. Biotite, aside from the case just mentioned, is sometimes seen in small flakes in the porphyritic

facies of the rock. Apatite occurs sparsely in short, stout prisms, and sphene is uncommon.

The writer expects to present soon an account of the geology of the region about Kekequabic lake, in which this interesting granite will be treated more in detail. There is reason to think that soda-granites will be found more extensively developed in the lake Superior region than has heretofore been supposed. It seems that some of the augite syenites of the Keweenawan, as already suggested,* may fall into this class, and there are numerous dykes in the Keewatin of northeastern Minnesota, described as quartz-porphyries and syenite porphyries,† a careful study of which will probably show that their feldspar is largely anorthoclase.

Thanks are due to Prof. G. H. Williams for kind suggestions and aid in the study of this granite; and to Prof. J. A. Dodge and C. F. Sidener of the University of Minnesota by whom the analyses were made.

Petrographical Laboratory, Johns Hopkins University.

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DRIFT MOUNDS NEAR OLYMPIA, WASHINGTON.

By G. O. Rogers, Dorchester, Mass.

Nature's architecture is always interesting, often beautiful; but frequently the history of a structure presents many perplexing difficulties to solve. Toward the western coast of Washington, a few miles south of Olympia, are found an immense number of peculiar tumuli, from three to five feet high, thirty feet more or less in diameter, regular in size, having the form of a broad-based cone, composed of a heterogeneous mass of sand and gravel, enclosing plentiful water-worn pebbles and cobbles, such as usually appear in modified glacial drift. These mounds cover a large area, embracing hundreds of acres, for the most part open prairie, with a very slight westerly dip. The forests, however, have encroached to such an extent that large numbers of the mounds are found within the timber. They can be numbered by thousands, and are

so plentifully distributed that in the open prairie they present the appearance of a vast field of hay-cocks. They are without order. The bases of many lie nearly contiguous, while others are many yards apart. The nearly level earth between the tumuli is more or less strewn with pebbles and cobblestones, similar in character to those of the mounds. These heaps at once attract the attention of ordinary observers as they pass through them on the railway train to and from Olympia. To the trained student of Nature they inspire a subtle and profound interest, but the attempt to solve the problem of their history involves many difficulties. For the last twenty years they have been studied with more or less care. Several theories have been presented, which require mention here.

The speculative hypothesis that the tumuli were built by fish while the land was submerged in comparatively still water seems improbable from their physical structure. Fish, forming heaps for breeding purposes, would not pack together sand, gravel and cobbles, as in these large mounds. It has been supposed by some that the Indians constructed them for burial places, or to clear the land. If for burial places, there should be found remains of some character to indicate the fact. If to clear the land for agricultural purposes, why heap the earth with the cobbles? Again, why take so much trouble, involving a vast amount of labor (which is not accordant with the Indian character), to clear the stony land, while millions of acres lie on every side already quite clear? Others have suggested "that they were raised as foundations for huts on a wet soil." The character of the soil of the mounds, and of the surrounding region, precludes this theory. It would seem that no careful observer can entertain either of the above views.

The remaining theory, and the only one which commands serious thought, is that of Prof. Joseph Le Conte,* of California, whose opinions should always be approached and viewed with the highest respect. He says, referring to the prairie tracts, often called "everglades," on which the tumuli are situated:

*Proceedings of the California Academy of Sciences, Dec. 15, 1873; Am. Jour. Sci., III, vol. vii, pp. 365-7, April, 1874. See also descriptions and discussions of the origin of these and similar natural mounds, by A. R. Wallace, G. H. Kinahan, J. Le Conte, W. M. Williams, J. Durham, and W. M. Gabb, in Nature, 1877, vol. xv, pp. 274, 379, 431, 530; vol. xvi, pp. 6, 7, 24, 183.

These are doubtless old bottoms of Puget sound, made dry by elevation. They are covered with drift soil. These grassy prairies are covered as thickly as possible with mounds, about three to four feet high, and thirty to forty feet in diameter. There are probably millions of them. The general appearance is that of almost perfect regularity of size and shape. The soil of the mounds is rather fine drift, with pebbles not larger than a pigeon's egg. The intervals between the mounds are strewed with larger pebbles. The mounds are occupied by ferns, the intervals only by grass. These treeless spaces are called 'mound prairies'........Erosion removes the finer top soil, leaving it, however, in spots. The process once commenced, weeds, shrubs, and ferns take possession of these spots as the better soil, or sometimes as the drier soil, and hold them, and by their roots retard the erosion there. In some cases a departing vegetation—a vegetation gradually destroyed by an increasing dryness of climate—is an important condition.

Professor Le Conte argues that the agency of erosion must account for these mounds. He starts with the idea that these tracts "are doubtless old bottoms of Puget sound, made dry by elevation." Did subsequent erosion take place? If so, it would appear that the newly elevated plain was comparatively smooth, a surface stratum of the same material as the present tumuli being quite evenly distributed over the entire area. Then "erosion" began, etc., as above quoted. At this juncture, I pause to point out what seems a grave error in at least one of Prof. Le Conte's affirmations. It would seem that he could not have personally examined these tumuli, or at least with care. He says: "The soil of the mounds is a rather fine drift, with pebbles not larger than a pigeon's egg. The intervals between the mounds are strewed with larger pebbles." Instead, the tumuli contain as large pebbles and cobblestones as those strewed between them. They range from the size of a pigeon's egg to three, five, or more inches in diameter. I think it is quite true, however, that the soil at and near the top of the mounds may be slightly finer, also that the pebbles may average a little smaller than those below. In fact one receives the impression that there is a gradation, not altogether uniform however, from finer material above to coarser below, throughout the mass. It is quite safe to affirm that more than half the bulk of these mounds is composed of coarse gravel enclosing large pebbles and cobbles, the major part of which are quite the same as between the mounds. Hence it is reasonable to suppose that if this area was elevated as a smooth plain, its surface was material like that of the mounds, evenly distributed. If then the finer mat-

ter was removed by erosion, as suggested, the intervals between the mounds would not be strewed with gravel stones so thinly distributed as to leave fairly good grazing for stock, but must have been abundantly covered with pebbles and cobbles. Again, it would seem irrational to suppose that any conceivable wind current could sculpture these mounds by erosion. There remains no other eroding agent but running water flowing in some general direction. Hence these mounds must have been elongated with their major axes parallel with the flow. Currents of water of sufficient force to sweep not only the finer matter but a mass of coarse gravel one to two feet deep from between the tumuli, yet leaving the mounds standing as they now appear, also seem quite inconceivable. Manifestly the facts that exist must exclude this hypothesis as well as those before noticed.

In offering the following explanation of the origin of these mounds, I would hesitate to say that there can be no other way to account for the phenomena, but must admit that I can see no other which will explain all the facts. At the least, it is earnestly hoped to enlist sufficient interest, if possible, to lead to a satisfactory solution of this question.

There appears to be sufficient evidence to warrant a belief, that during the Glacial period this region was ploughed over by moving ice. It lies within the southern edge of the drift-bearing area, as mapped by Chamberlin. The general appearance, however, would not warrant one to affirm that this locality was covered by an ice-sheet moving in the same general direction as that east of the Rocky mountains, but rather of a local character, similar to those now existing in Alaska, which start from the crests of the mountains and flow in all directions into the valleys and onto the plains below, carrying forward and distributing the glacial drift as worn boulders, cobbles, sand, and gravel. During and after the retirement of the glacier, the drift was greatly modified by floods of water, the result of the wasting ice and frequent rains. East of the tumuli plain, the land, much of which is now under farm cultivation, gradually rises toward the remote mountains. Wells are sunk in this land from which to obtain water for domestic purposes. At the surface the soil is from one to three or more feet deep and overlies a coarse cobble drift, which is composed of material alike in character with that of the mounds. The wells pass through from six to ten feet of this cobble drift to a substratum of finer

gravel into which the wells extend from two to four feet, where permanent water is secured.

Imagine this large tumuli plain to be covered with a sheet of ice reduced to a moderate thickness by ablation on the border of the retiring active glacier, and having, like the forest-covered border of the Malaspina ice-sheet in Alaska, no motion except the gradual waste by liquefaction. However, the forces which modify the drift are yet active, so that boulders, cobblestones, gravel, and sand are being brought forward from the higher levels by periodic floods, the product of accelerated melting of the glacier during a prolonged increased temperature. From time to time, during the especially rapid melting in the summers, the greater floods would overflow the entire ice-plain, carrying along with them the smaller boulders, cobbles, gravel, sand, and clay or finest silt of the drift, which would be spread on the ice surface. It is a well observed fact that coarse gravel carried onto a plain by a strong flow of water has a tendency to accumulate in masses or heaps. A slight depression in the surface, or some obstruction, may arrest the onward movement of a boulder or large cobblestone, while the finer material would more or less pass on. This boulder might stop another, and so on, the general result being a somewhat unequal distribution of the drift over the surface of the ice. The flood as its force decreased would manifestly leave the whole surface more or less covered with the drift débris. As the sun sends its rays onto the drift thus distributed with its substratum of ice, three agencies modifying the drift claim our consideration, namely, heat, gravitation, and the accumulation of water in the depressions. The thicker masses of débris would collect more of the heat of the sun and this would cause a faster melting of the ice or in other words would make a depression at such points, into which gravitation would carry additional drift by sliding from the adjacent ice surface and by the washing action of rains and streamlets.

After formulating this hypothesis in regard to the tumuli of the "mound prairies," I was very much gratified in finding the following statements which add greatly to the strength of my argument.

Prof. I. C. Russell, in his work on the glaciers of Alaska,* gives on page 120 the following description of lakelets on the

*"An Expedition to Mount St. Elias, Alaska," National Geographic Magazine, vol. iii, pp. 53-203, with nineteen plates, May 29, 1891.

Malaspina glacier or ice-sheet, occupying deep well-like depressions or pits constricted half way down, somewhat in the shape of an hour-glass, into which the drift exposed by ablation on the contiguous ice surface falls, so that it would be left as a mound if the ice were melted away.

On the moraine-covered portion, especially where plants have taken root, there are hundreds, perhaps thousands, of lakelets, occupying kettle-shaped depressions.......If we should go down to the glacier and examine such a lakelet near at hand, we should find that the cliffs of ice surrounding them are usually unsymmetrical, being especially steep and rugged on one side and low or perhaps wanting entirely on the other. But there is no regularity in this respect; the steep slopes may face in any direction. On bright days the encircling walls are always dripping with water produced by the melting of the ice; little rills are constantly flowing down their sides and plunging in miniature cataracts into the lake below; the stones at the top of the ice cliffs, belonging to the general sheet of débris covering the glacier, are continually being undermined and precipitated into the water. A curious fact in reference to the walls of the lakelets is that the melting of the ice below the surface is more rapid than above, where it is exposed to the direct rays of the sun. As a result the depressions have the form of an hour-glass.

Speaking of the Galiano glacier, on page 89, Russell says:

My surprise therefore was great when, after forcing my way through the dense thickets, I reached the top of the hill, and found a large kettle-shaped depression, the sides of which were solid walls of ice fifty feet high. This showed at once that the supposed hill was really the extremity of a glacier, long dead and deeply buried beneath forest-covered débris. In the bottom of the kettle-like depression lay a pond of muddy water, and, as the ice-cliffs about the lakelet melted in the warm sunlight, miniature avalanches of ice and stones, mingled with sticks and bushes that had been undermined, frequently rattled down its sides and splashed into the water below. Further examination revealed the fact that scores of such kettles are scattered over the surface of the buried glacier.

Again, on page 111, he says of the Hayden glacier:

The débris is scattered over the surface in a belt several rods wide; but it is not deep, as the ice can almost everywhere be seen between the stones. Where the fragments of rock are most widely separated, there are fine illustrations of the manner in which small, dark stones absorb the heat of the sun and melt the ice beneath more rapidly than the surrounding surface, sinking into the ice so as to form little wells, several inches deep, filled with clear water. Larger stones, which are not warmed through during a day's sunshine, protect the ice beneath while the adjacent surface is melted, and consequently become elevated on

pillars or pedestals of ice. The stones thus elevated are frequently large, and form tables which are nearly always inclined southward. In other instances the ice over large areas, especially along the center of the medial moraine, was covered with cones of fine, angular fragments from a few inches to three or four feet in hight. These were not really piles of gravel, as they seemed, but consisted of cones of ice, sheeted over with thin layers of small stones. The secret of their formation, long since discovered on the glaciers of Switzerland, is that the gravel is first concentrated in a hole in the ice and, as the general surface melts away, acts like a large stone and protects the ice beneath. It is raised on a pedestal, but the gravel at the borders continually rolls down the sides and a conical form is the result.

Allowing conditions like these of the Malaspina, Galiano, and Hayden glaciers to have existed on the melting ice-sheet of the tumuli plain in Washington, we are prepared to look over its area and observe thousands of kettle-shaped hollows, pits, and wells in the ice, containing water and becoming filled with drift gravel and sand. A winter comes and while the temperature is below the freezing point the water in the holes is congealed, hence all further action ceases until the spring time brings a higher temperature. Then these numberless holes are ready to receive the oncoming flood and the fugitive drift matter supplied by the melting and receding glacier. It is quite obvious that as the drift débris was swept over the ice field, these wells would be more or less filled with clayey silt, sand, and fine and coarse gravel, corresponding to the force of the water current. Perhaps this phenomenon was repeated for several or many years. At last the parent glacier has become so wasted and remote that no more floods occur, and at the same time by gradual melting the ice-sheet has quite disappeared, leaving these accumulations of drift matter intact. By such processes this large area would be left covered with tumuli substantially as they exist to-day. It would matter little whether the walls of the circular pits or wells in the ice were vertical or inclined at various angles or shaped like an hour-glass, as Russell observed on the Malaspina glacier or ice-sheet. The enclosed masses of stratified drift, when their supporting ice walls were melted away, would naturally assume no other form than the one in which they now are found, as broad-based, cone-shaped mounds.

THE GENERIC EVOLUTION OF THE PALEOZOIC BRACHIOPODA.

By AGNES CRANE, Brighton, England.

It is a time-honored saying that "a prophet is not without honor save in his own country," but the name and fame of professor James Hall, LL.D., director of the State museum of Natural History of New York and its veteran state geologist, are well known in Canada and the United States and have long been recognized and appreciated among the geologists and invertebrate paleontologists of Europe. The highest recognition in geological circles was accorded him nearly a quarter of a century ago, when he was awarded the Wollaston Medal of the Geological Society of London, the year after Barrande, and a year before Charles Darwin received it. His arduous life-long researches have resulted in the production of the fine series of monographs of "The Paleontology of New York," of which Vol. VIII, Part I, Brachiopoda,* by James Hall, assisted by John M. Clarke, has recently made its appearance, with an unusually interesting text and the well-executed plates for which the series has been remarkable. As a fossil brachiopodist professor Hall ranks with his eminent contemporaries, the late Dr. Thomas Davidson, F.R.S., and Joachim Barrande of Prague. In one respect he may be said to take higher position as a philosophical investigator, inasmuch that he kept free from prejudice with regard to the theory of evolution as applied to the class Brachiopoda at a time when, owing to the condition of our knowledge of the group, it was not possible to adduce actual proofs of the logical postulate in that direction.

Times and methods have changed indeed since the celebrated Bohemian paleontologist definitely proclaimed that the evidence of the Cephalopoda† and of the Brachiopoda‡ was opposed to the truth of the theory of evolution, and Dr. Davidson, in answer to a personal appeal from Darwin, replied that he was unable to detect direct evidence of the passage of one genus into another.§

There has been a marked advance in the philosophical treatment of this important group of ancient and persistent organisms during the last decade, and to this progress American scientists have contributed largely. Mr. W. H. Dall has differentiated and described some new genera and species of the recent forms of interest and value. Professors

*Natural History of New York. Paleontology, vol. viii. (Geological Survey of the State of New York.) "An Introduction to the Study of the Genera of Paleozoic Brachiopoda." Part I. By James Hall, state geologist and paleontologist, assisted by John M. Clarke. Albany, 1892.

†Cephalopodes, Etudes Générales par Joachim Barrande, Prague, 1877, p. 224.

‡Brachiopodes, Etudes Locales, Ibid., 1879, p. 206.

§"What is a Brachiopod?" by Thomas Davidson, F. R. S., Geological Magazine, Decade II., vol. iv, 1877.

Morse, Brooks, and Beyer, and of late Dr. Beecher and Mr. Clarke, have revealed suggestive phases in the developmental history of typical genera and well-known species. Now professor James Hall and Mr. J. M. Clarke have sifted and compared the vast accumulations of data recorded by earlier writers by the older methods of descriptive paleontology, and, combining the results thus gained with the best features of the new school of investigators, have effected a revolution in the general treatment of the entire class of Brachiopoda. They trace important stages in the phylogeny of the fossil forms and various links connecting them through their immediate successors with the surviving members of the group.

Much of this work could not possibly have been accomplished had it not been for the mass of descriptions and figures of the vast number of species recorded in the work of Barrande, Davidson, De Koninck, D'Orbigny, Defrance, Deslongchamps, Suess, Lindstrom, Pander, Quenstedt, Geinitz, Littell, Oppel, Oehlert, Waagen, and Neumayr, in Europe, and Billings, Hall, Clarke, Meek, Shumard, Worthen, Walcott, White, Whitfield, and others on the continent of America.

The warm and discriminating recognition of the valued labors of his European fellow-workers is one of the most agreeable features of professor Hall's new volume. It is pleasant to read "of the greatest of all works on the Brachiopoda by Thomas Davidson," of the just appreciation of Barrande's herculean efforts in the Silurian field, of the excellence of William King's anatomical investigations, to find Pander's early work valued and his names restored. These are just and generous tributes to the memory of comrades who have gone before, most welcome in these latter days of that strident "individualism" which is often mere egotism in disguise.

The New York paleontologist's recent work is not only a critical *résumé* with descriptions and figures of the Brachiopoda of New York, but a careful analysis of the results of the labors of his predecessors and contemporaries in the same extended paleozoic field of research in the United States, Canada, Russia, Sweden, and Great Britain. This gives it a cosmopolitan value, and affords opportunity, by means of critical comparisons of genera, species, and varieties from the geological horizons of both hemispheres, to recognize the identity of species, to define synonyms, to collate genera and sub-genera, to indicate their inter-relationships, and to illustrate the passage-forms linking one group, or assemblage of allied genera, to another. To this branch of the subject we must now restrict our observations.

With singular modesty the authors refrain, for the present, from proposing any new scheme of classification. The primary division of the class into two orders comprising the non-articulated and articulated genera is adopted. We fail to see why Owen's names of *Lyopomata*, or "loose valves," and *Arthropomata*, or "jointed valves," should have been discarded, for they define the same limits and distinctions as Huxley's simpler, but later, names, *Articulata* and *Inarticulata*, the first of which was employed by Deshayes to designate certain forms of Brachiopoda

before the publication of Huxley's "Introduction to the Classification of Animals." In England it is generally conceded that the priority and scope of Owen's orders were clearly established by the American systematist, Dr. Theodore Gill. The matter, however, is of less moment now that a general tendency to admit greater ordinal subdivision has arisen. Waagen has proposed six orders, Neumayr eight, and Beecher four, based on the peduncular opening and associated characters.

The names *Inarticulata* and *Articulata* express certain general distinctions. Nevertheless, it is a matter of fact that forms have often appeared which cannot be separated thus, for tendencies to transgress these artificial limits become apparent in various directions. For instance, the species of the Silurian genus *Trimerella* was shown by Davidson and King to be but feebly articulated, and now *Neobolus*, *Spondylobolus*, and Hall's new linguloid genus *Barroisella*, are shown to exhibit the same propensity. We are glad to note that, although fifteen years have elapsed since the publication of the Memoir on the *Trimerellidæ*, by Thomas Davidson and William King,* it is frankly admitted that later observations have hitherto added comparatively little to the results achieved by those eminent investigators and have taken away nothing from their value.

In the present publication the semi-artificial, but convenient, family designations are not adopted, but the genera discussed fall into groups of associated genera, often exhibiting intermediate characters, which link one genus naturally with another. More has been accomplished in this direction than could possibly have been anticipated, and the eighth volume of the Geological Survey of the State of New York (Paleontology) would have made glad the heart of Darwin, for its dominent note is the evolution of genera.

Hitherto *Lingula* has always been regarded as taxonomically at the base of the Brachiopoda, in spite of the acknowledged complexity of its muscular system and the date of its appearance in the geological series. It is now shown conclusively to be developed from an obolelloid type which culminated in a faunal epoch anterior to the appearance of *Lingula*, and Brooks' history of the development of the living species is cited as confirmatory proof of the direct obolelloid derivation of the paleozoic *Lingulæ* from *Obolella*. *Lingulella* and *Lingulepis*, forerunners of *Lingula*, may be found to be important connecting links, having the outward form of linguloids with the muscular arrangements and narrow pedicle slit of the obolelloids. "The development on the linguloid line has continued, as we believe, from early Silurian to the present time with frequent modifications. From *Lingula* we may depart in many directions. In *Lingulops* and *Lingulasma* we get indications of physiological influences on the origin of genera."

It appears that "augmented muscular energy and concomitant increased secretion of muscular fulcra," with the large size and consequent displacement of the liver, induced the thickening of the entire area of

*Quarterly Journal of the Geological Society of London, vol. xxx, p. 124, 1874.

muscular implantation. Gradual excavation of this solid plate ensued, and the formation of a more or less vaulted platform, extremely developed, in the feebly articulated trimerellids of those Silurian seas, which favored the rapid development of the platform-bearing Brachiopoda, a race which was abruptly exterminated at the close of the Niagara and Wenlock period. Hall's new genus *Barroisella* is a divergent so marked by the development of deltidial callosities as to indicate their approximating specialization for articulating and interlocking purposes. Thus we get most striking evidence of a tendency to span the interval between the so-called edentulous *Inarticulata* and the articulated genera in the Linguloid and Trimerelloid groups.

The genus *Obolus* is shown to be more specialized than *Obolella*, less so than *Lingula*, *Neobolus* being an intermediate form with cardinal processes, also indicative of progress in this direction towards the *Articulata*. In *Obolus*, however, the muscular scars are excavated as in *Lingula*, not elevated as in the forms tending to *Trimerella*. Thus we get indications in the history of the ancestral Trimerellids of the attainment of a like remarkable resultant along distinct lines of development, of which another instance has been furnished by Messrs. Fischer and Oehlert's recent studies of the development of the living *Magellanæ* of the boreal and austral oceans, to which we had elsewhere occasion to refer.* As Hall and Clarke's generalizations are formulated with a due regard to geological sequence, they possess more validity than the phylogenetic deductions enunciated by a Teutonic paleontologist, in which that important factor was somewhat neglected.† "We have yet to seek," the American brachiopodists conclude, "the source whence these numerous closely allied primordial groups are derived, in some earlier comprehensive stock of which we have yet no knowledge. The ages preceding the Silurian afforded abundant time for a tendency to variability to express itself" (p. 168).

From this satisfactory discussion of the origin and development of the paleozoic unarticulated genera and species, Hall and Clarke proceed to consider the structure and relations of the far more numerous and more complicated order of the articulated species, and commence with the Orthoids, the lowest forms of the Articulata, as, by common consent, they are now regarded. The allied strophomenoids, streptorhynchoids, and leptænoids, as defined by Dalman, are then treated of and the first part terminates with a discussion of some Carboniferous productoids. The spire-bearers, rhynchonelloids and terebratuloids, of the Paleozoic seas are thus left for the concluding volume, when we may look for a valuable general summary of results and for that systematic classification, based on their completed investigations, which the authors are bound to propose in the interests of students for the root, stem, branches, and twigs of the genealogical tree of the Brachiopoda, as they have definitely abandoned the family names hitherto in vogue. It

*On the Distribution and Generic Evolution of some recent Brachiopoda, by Agnes Crane, Natural Science, January, 1893.

†Neumayr, "Die Stämme des Thierreichs Brachiopoda," 1890.

must certainly be admitted that brachiopodists have often found it difficult, and sometimes impossible, to determine to which of two well characterized families certain annectent forms should be definitely referred.

In Europe, however, the retention of family designations is not always considered incompatible with the modern philosophical and evolutional methods of class treatment. They have been preserved with advantage; for instance, in Mr. A. Smith Woodward's* masterly systematic classification of the fossil fishes in the British Museum, and also in professor W. A. Herdman's† exhaustive report on the Tunicata dredged by the "Challenger" expedition, associated in this case with evolutional data and the presentation of numerous phylums showing the inter-relations of genera, somewhat after the same plan as that adopted in the "Introduction to the Study of the Paleozoic Genera of Brachiopoda." With all due respect to the veteran of the old school and the disciple of the new, we venture to submit the impossibility of impressing on the mental retina a permanent photograph of the innumerable and fascinating phylums which they have provided with such industrious research. But we are not all endowed with so much insight, knowledge, and experience.

The most revolutionary feature in the present installment of their researches on the *Articulata* is the extreme subdivision to which the great group of Orthoids has been subjected. The genus *Orthis* is absolutely restricted to eight species (instead of two hundred), with *O. callactis* of Dalman as the type, and his early figures and original descriptions are judiciously reproduced for the benefit of American students. The remainder of the large number of species are placed under various new genera and sub-genera, or restored to their former appellations. For instance, Pander's name, *Clitambonites*, is once more applied to species unjustly usurped by D'Orbigny's *Orthisina*, and *Plectambonites* of the same Russian paleontologist is restored for the Paleozoic species grouped by the French conchologists and those who followed them under the genus *Leptæna* of authors, not of Dalman. The *Leptæna rugosa* of this author is taken as the type of his genus, the scope of which is thus much restricted, and new generic names are proposed for several of the species indifferently described as *Strophomenas* or *Leptænas* by various authors. Linné's sub-genus *Bilobites* is revived for those abnormal bilobed species of *Orthis*, which, according to Dr. Beecher's investigations, originated from a normal form at the adolescent and mature stages of growth in both direct and indirect lines of development. In view of the extensive breaking up of the orthoids, here proposed, into several genera and subgenera, we are willing to confess that to object to the revival of *Bilobites* would be but straining at a gnat and swallowing the camel. We, however, admit a preference for those among the proposed new or re-

*A Catalogue of the Fossil Fishes in the British Museum, Part I., 1889; Part II., 1890.

†Reports of the "Challenger" Expedition: Tunicata, vols. vi, xiv, and xxvi.

stored designations which give some indications of the former position of the species among genera. Such are *Protorthis*, *Plectorthis*, *Heterorthis*, *Orthostrophia*, *Platystrophia*, and so on. *Orthidium* for the generic divergent nearest allied to *Strophomena* seems a less happy selection. Tabular views, both instructive and suggestive, are given to show the approximate range in the geological horizons from the Calciferous shales of the Lower Silurian to the Upper Coal Measures which indicate the appearance, persistence, and extinction of the various genera into which, under new, old, or restored appellations, the orthoids, strophomenoids, and leptænoids are subdivided—a subdivision which, with its associated shifting of types, will not escape criticism.

There will always be differences of opinion respecting generic values. Here, as Heckel long ago pointed out, the personal equation becomes prominent. We believe professor Cope was the first to advance the then heterodox view that species could be transferred from one genus to another without affecting their specific characters. Many so termed genera represent what have now become abbreviated transitional phases in the development of the race which, of old time, became stereotyped for periods of longer or shorter geological duration. The researches of Friele and Oehlert on the recent Magellanæ (*Waldheimia*), the ultimate phase of development of the long-looped branch of the Terebratuloids, illustrate this point most clearly. If the inter-relationships and passages of these generic phases are carefully noted, they become so many illustrations of one method of the evolution of genera, which sometimes, it is evident, originated from causes incidental to individual development, accelerated growth, and the circumstances of the environment.

Professor Hall evidently considers it better to deal with a small number of well-characterized species instead of a large number of ill-defined forms, and that such minor structural internal modifications as can be shown to be constant in a recognized geological horizon should be raised to generic or sub-generic rank. The description and portrayal of such generic divergences afford the best means for general comparison and thus tend to promote a clearer comprehension of the manifold phases of the evolution of genera. The fact that specific characters sometimes make their appearance in individual development before generic features is most suggestive. For the laws of "science and growth"* first made known by Heckel, and since extended by Hyatt to the Cephalopoda, Jackson to the Pelecypoda, and Beecher and Clarke to the Brachiopoda, the term auxology† has been lately proposed by English systematists, with some elucidative and etymological modifications in Hyatt's terminology. These principles govern individual and specific development of genera, for genera are stages in the life history of the race, as distin-

*Auxe, growth, and logos, science.

†See a paper entitled "The Terms of Auxology," by S. S. Buckman, F. G. S., and F. A. Bather, M. A., F. G. S., London, in the Zoölogischer Anzeiger, No. 405 and 406, p. 420, Nov. 14 and 28, 1892.

guished from the genealogical records of the individual. It would seem, however, that just as the co-existence of a large number of individuals tends to perpetuate specific variation, so the simultaneous occurrence of abundance of species in one horizon and area is productive of the divergence of genera.

We cannot enter further into details; enough has been written to show beyond contradiction the value and interest of this "Introduction to the Study of the Genera of Paleozoic Brachiopoda," with its concise descriptions of genera and passage-forms, their inter-relations, and affiliated species. It is rendered complete by excellent specific bibliographies, well considered genealogical trees, showing the common ancestry, diverging lines of descent, and affinities of genera, with their geological range, a register of genera and of species, authors, and general index. The work is most creditable to professor James Hall and his assistant, Mr. J. M. Clarke, and reflects honor on America in general and the state of New York in particular. It deserves to be carefully studied by invertebrate biologists in both hemispheres. We trust the publication of the second part will be proceeded with, and that by its rapid completion, on similar lines of thought, science may be enriched by a general view of the evolution of the Brachiopoda. It is much to be desired that the relations of the Secondary and Tertiary species should be discussed in a like thorough, philosophical, and generally satisfactory manner.

We have become so convinced of the advantages of this method of treatment, that we have begun to form the nucleus of a collection in the Brighton Museum, destined to illustrate the evolution of genera among the Brachiopoda.—*Science.*

AN EXTINCT GLACIER OF THE SALMON RIVER RANGE.

By GEO. H. STONE, Peyton, Colorado.

West of Salmon City, Idaho, lie the Salmon River mountains. They rise quite steeply from the adjoining valleys to an elevation of somewhat more than 8,000 feet above the sea. The range is very snowy, being well exposed to the moist winds from the Pacific ocean. Its rocks consist of very ancient quartzites, slates and schists, alternating with areas of coarse granites and a few extrusions of rather recent acidic volcanic rocks. The main range trends nearly north and south, and there are several spurs projecting westward and northwestward. The masses of upheaval have been dissected into a multitude of valleys and cirques and show every sign of geological old age.

Napius creek drains a large area on the western slopes of these mountains. It flows nearly west and is a tributary of Big creek, which flows north into the Salmon river. I have had opportunity to explore cursorily the upper twenty miles of this valley, extending to a point about seven miles west of Leesburg and down to the elevation of about 5,700 feet above the sea. Here the river or creek, which is a large stream during the melting of the snow, has cut a deep cañon through a high northeast and southwest ridge of granite, and thence it descends steeply to Big creek by a series of rapids and cascades. This point is known as the Falls of Napius, and lies at the foot of the flat known as Bull of the Woods. East of this granite dike there is an outcrop of several square miles of volcanic rock, bordered by a broad crescent of schists, which in turn is bounded by a belt of granite. The alternation of different rocks makes it easy to distinguish drift from local matter. Into the main creek flow numerous lateral tributaries, from five to ten miles long. The area of that portion of the valley to be described is about 300 square miles. Near the main creek the hills are not usually more than 200 to 400 feet high, and thence the hills and ridges separating the adjacent valleys rise higher as we go upward toward the top of the range. Near Leesburg the hills adjoining the creek are unusually low, and thus there is formed a sort of rolling plain enclosed by higher hills. At one time all the higher valleys and cirques were filled by glaciers which flowed down into the main valley where they covered all the hills near the main stream, thus being a confluent glacier or ice-sheet enveloping not only the main valley, but also a broad belt on each side extending back into the lateral valleys. The following four kinds of morainal masses are found.

1. *Lateral Moraines.* These do not take the form of distinct ridges or terraces on the sides of the hills next the main stream, but are seen as a sheet or diffused scattering of erratics.

2. *Terminal or Retreatal Moraines.* About two miles east of the Falls of Napius is a moraine beginning near the river and extending northward up a hill to an elevation of about 800 feet above the stream. It takes the form of a low ridge with gentle side slopes and in places is 500 feet or more broad, with several outlying spurs. Most of the material shows evident glaciation. On the south side of the creek is a corresponding moraine on top of a high north and south ridge. Near the creek this moraine does not show

on a precipice of volcanic rock. Two miles east is another but smaller moraine transverse to the main valley, and there are several small ones at various points above. The great depth of ice here makes it certain that the glacier at its maximum development extended far down the valley beyond the limits described. These terminal moraines are therefore retreatal.

3. *Crag and Tail.* The high granite ridge extending northeastward from the Falls of Napius creek shows no erratics that I could find, until we reach a point about three-fourths of a mile from the stream. Here on the top of a broader part of the ridge is a moraine of intensely glaciated matter forming a sheet a few feet thick, nearly an eighth of a mile long, and 200 or 300 feet wide at its widest place. It was formed in the lee of a small peak of volcanic rock that rises abruptly about 30 feet above the rest of the ridge. A narrow moraine borders the stoss side of this little peak and a few erratics are also found on the other two sides. Perhaps a better name for this arrangement would be Crag and Collar. This is at an elevation of about 500 feet above the contiguous portion of the main valley.

4. *Crag and Cap.* Three miles east of the last named locality and one mile south of the main creek is a hill rising 800 feet above the river. It is capped by a moraine forming a ridge about 50 feet thick, 250 feet wide at base, and about an eighth of a mile in length. The moraine consists largely of quartzite and granite, many of the granite boulders being ten and even twenty feet in diameter. The local rocks are schists. For a fourth of a mile on the lower slopes of the hill I could find no erratics, except on one steep slope where a few may have slipped down the hill. The longer dimension of the ridge is parallel with the main valley, presumably the direction of glacial flow at this point. In several other places there are moraines capping the hills.

Large areas between these high moraines show little or no morainal matter. In other words, we find local deposits, not a sheet of till such as covers New England. The third and fourth varieties of moraines here described, designated as "crag and tail" and "crag and cap," were probably deposited under the same conditions as those that are now being formed on the sides and tops of nunataks of the Greenland ice-sheet. The hills bearing these peculiar moraine accumulations rose nearly to the surface of the ice or a little above it. Part of their moraine stuff is intensely gla-

ciated and may have been brought in the lower part of the ice. A part shows few or no signs of glaciation, especially the granite boulders, and probably was brought here on the surface of the ice. These "nunatak moraines," as they may be named, show a marked contrast to the local rocks both in the glaciated shape of the stones and the materials of which they are composed.

Another class of drift deposits on this area demands attention. A sheet of gravel and well rounded stones and boulders covers the bottoms of the main valley and of most of the lateral valleys until we approach the cirques in which the glaciers originated, where we find only unmodified morainal matter. Most of the stones have been very much rolled and rounded by water, but in places there is an admixture of stones bearing glacial scratches. The scratched stones become more numerous in the gravel as we go back from the main valley. This sheet of water-rounded matter has been eroded by the streams to depths varying from 30 to 70 feet, leaving the uneroded borders of the original sheet in the form of terraces, known to the placer miners as the "high bars." In places they are only three or four hundred feet wide, but not far west of Leesburg one of these terrace plains expands to a width of nearly two miles. Excavations for placer mining show this gravel sheet to be from 10 to 60 feet thick, resting on the glaciated bed-rocks. The surface of the terraces has a slow ascent as we go back from the main creek, its rate being in most places about 100 feet per mile. A vast amount of well rounded gravel and cobbles continues along the lower part of this valley.

It is evident that this water-rounded matter was rolled and polished by the subglacial streams. The surface is rather even, and we find no kame ridges nor reticulated kames. The gravel (including vast numbers of cobbles, boulderets, and boulders) was poured out in front of the retreating ice, being at the same time mixed with stones that fell down from the extremity of the ice and thus received too little water-wear to efface the glacial scratches. Possibly some of the broad tracts of the gravel and sand occupy the place of glacial lakes caused by lateral glaciers continuing to flow across the main valley after the ice from the upper part of that valley had retreated.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Eléments de Paléontologie, par FELIX BERNARD, *Première partie* (pp. 528) *avec 266 figures dans le texte.* Paris, Baillière et fils, 1893. The whole work will form a volume of 1,000 pages, with 600 figures in the text, at a cost of twenty francs. The work is not a mere compend of previous publications, but aims rather to be a philosophical review of paleontology in the light of the theories of evolution, taking note of important memoirs, whether French or foreign, which have appeared up to the very moment of printing. Fossil forms are frequently compared with living species. This gives naturalness to the grouping and a fresh biological aspect to the comparisons and conclusions.

Opening with a brief statement of the relations of paleontology with the other sciences, the author falls into a very interesting "History of Paleontology," dating its actual foundation, as well as that of comparative anatomy, from the brilliant work of Cuvier. He divides the whole history into three periods: first, that which preceded Cuvier; second, the interval between Cuvier and 1857, a period characterized specially by descriptive details of extinct species; and third, from 1857 to the present, characterized by broader philosophical groupings, and by the rise of the "transformist school," or evolutionists. This period is marked by the most minute precision in its observations, the effort being to derive from the organism all that it is possible to know of its morphology, its structure, and its development. It is in the realm of this period that the work of the author lies principally, and in the profound change which the science of paleontology has undergone since the variation of species was recognized as a fundamental law he discovers the effect of the doctrine of evolution. Evolution and paleontology have mutually aided each other.

In seeking for a definition of a species he shows, by reference to the researches of Hilgendorf on Planorbis, confirmed and extended by Hyatt, that numerous species could be founded on forms which were, it is true, very variable, but which were actually derivable the one from the other. The work of Waagen on Ammonites subradiatus resulted in the union of many apparently specific forms under the common name Oppelia. Waagen used the term "variation" when the differences were found in different localities from the same stratum, but "mutation" when they appeared at the same locality in different strata. Neumayr reached the same result in studying the Paludinas of the upper Miocene. From these works a new point of departure at once sprang up for paleontology. The immutability of species, taught by Cuvier, was disproved, and at the present time there is no possibility of defining a species. Each paleontologist erects his own standard. The grand purpose is now to trace lines of development, and as the author remarks, "such research

is much more fruitful than that which consists in distinguishing more than a hundred species of Unio in the waters of France, or in making, unwittingly, several species from two branches of the same plant."

The entire work is established on a perfect sympathy with evolution. He refers frequently to American Neo-Lamarckians such as Hyatt, Cope, Riley, Marsh, and others of what he calls the *American school.*

The volume contains numerous figures, many of them new. It comprises the science in its present aspect, in the light of the latest research. It is an important and welcome addition to the literature of geology in the nineteenth century, and will constitute one of its noteworthy steps of advance.

Finite Homogeneous Strain, Flow, and Rupture of Rocks. By GEORGE F. BECKER. Bulletin of the Geological Society of America, vol. iv, pp. 13-90, with 22 figures in the text; Jan. 3, 1893. From experiments and elaborate mathematical investigation, the author explains the flow, shear, and faulting of rocks, and the origin of joints, schistose, and slaty cleavage, and basaltic columns. The columnar structure is attributed, as by former writers, to rupture by tension in the process of cooling and contraction. Joints are referred to simple unrotational pressure, which produces two sets of fissures crossing each other at angles approaching 90° if the rock is brittle, but gives when the rock is plastic two sets of schistose cleavages. "The line of force bisects the obtuse angles of the cracks or cleavages." The accepted theories of slaty cleavage are shown to be erroneous, and it is ascribed instead to rotational pressure, receiving no aid from the presence of mica scales or flattened particles of the rock mass. "The most important result of the investigation is that jointing, schistosity and slaty cleavage all imply relative movement, and are thus as truly orogenic as faults of notable throw. They may all be regarded as orogenically equivalent to distributed faults. The great number of joints and planes of slaty cleavage compensates for the minute movement on each, and the sum of their effects is probably at least as important as that of the less numerous faults of sensible throw. In the light of this conclusion it appears that if one could reproduce the orogenic history of the Sierra [Nevada] in a moderate interval of time on a model made to a scale of one mile to the inch, it would seem to yield to external and bodily forces much like a mass of lard of the same dimensions."

The Thickness of the Devonian and Silurian Rocks of Central New York. By CHARLES S. PROSSER. Bulletin, G. S. A., vol. iv, pp. 91-118; Feb. 21, 1893. Detailed sections are recorded for twelve deep wells in the south to north belt in central New York which includes Binghamton, Utica, Syracuse, and Watertown. The thicknesses of the several formations in descending order, reaching down to the Archæan, are found as follows: Chemung (in part) and Portage, 2250 feet; Hamilton, 1785; Marcellus shale, 100(?); Upper Helderberg (Corniferous limestone), 93; Oriskany sandstone (?); Lower Helderberg, 186 (?); Onondaga Salt group, 1239+; Niagara, 52 (?); Clinton, 323; Medina, 520; Oswego sandstone, 107; Lor-

raine shale of the Hudson group, 640; Utica shale, 233; Trenton, 637+; Calciferous, 320 (?); and Potsdam, 410 (?). This general section is compared with two others measured by Mr. Prosser farther west in New York, respectively following the valleys of Cayuga lake and of the Genesee river, and with one section determined in eastern New York by C. A. Ashburner, from the top of the Catskill mountains to the bottom of the Mohawk valley.

A new Tæniopteroid Fern and its Allies. By DAVID WHITE. Bulletin, G.S.A., vol. iv, pp. 119-132, with a plate and diagram indicating hypothetical relations; Feb. 23, 1893. The fern here described, *Tæniopteris missouriensis*, is represented by eleven specimens collected in the Lower Coal Measures 8 to 9 miles south and southeast of Clinton, Mo. The species is of peculiar interest from certain features showing close relationship to the genus *Alethopteris.*

Some Elements of Land Sculpture. By LEWIS EZRA HICKS. Bulletin, G. S. A., vol. iv, pp. 133-146, with twelve figures of erosion outlines; Feb. 25, 1893. The processes of subaërial land erosion by weathering and by the washing of rains, rills, and larger streams are instructively discussed, with illustrations chiefly taken from the area of the great plains and bad lands in the region drained by the Missouri river.

Some Dynamic and Metasomatic phenomena in a metamorphic conglomerate in the Green mountains. By CHARLES LIVY WHITTLE. Bulletin, G. S. A., vol. iv, pp. 147-166, with a plate showing secondary enlargement of clastic tourmaline, and five figures in the text; Feb. 25, 1893. The formation studied is a Lower Cambrian conglomerate, in large part changed to ottrelite schist, which phase attains a thickness of several hundred feet and is traced several miles across the anticlinal axis of the Green mountain range, from Mendon eastward to North Sherburne, in the northeast part of Rutland county, Vermont. The latest change that this schist has undergone is the incipient alteration of its ottrelite into chlorite. In Chittenden, the next township on the north in the same county, the stratigraphic continuation of the ottrelite schist is a well-marked conglomerate, in which quartz pebbles and small boulders, up to 18 inches in length, make nearly 90 per cent. of the detrital material. Gneiss and feldspar pebbles are also common, the latter being occasionally two to three inches long. The groundmass consists of granular quartz, magnetite, plates of muscovite, and prisms of sericite. In this rock small fragments of tourmaline crystals, often water-rounded, have been filled out by the deposition of secondary tourmaline perfectly oriented with the core, in the same way as the enlargements of quartz grains which have been described by Irving and Van Hise. In one of the examples figured the secondary growth is bounded by nearly complete crystallographic faces.

Notes on a little known region in northwestern Montana. By G. E. CULVER. Trans., Wisconsin Academy of Science, Arts, and Letters, vol. viii, pp. 187-205, with map; Dec. 30, 1891. Besides many valuable observations on the topographic features and stratigraphic geology of the

area traversed by Prof. Culver, he gives very interesting details of the glacial drift and of an ice-dammed lake. Within thirty miles southward from the 49th parallel, ice was accumulated so thickly west of the main eastern range of the Rocky mountains that it outflowed eastward through the passes, carrying diorite boulders from ledges west of the watershed to a distance of several miles on the plains at the eastern base of the mountains. No Laurentian drift was observed there, but in the valley at the head of St. Mary's river, a tributary of the Belly river, on latitude 113° 30′, five to twenty miles south of the international boundary, shore lines of a glacial lake, which was probably formed by the neighboring barrier of the Laurentide ice-sheet on the northeast, occur up to the hight of at least 800 feet above the present St. Mary's lakes, or approximately 5,400 feet above the sea.

Estimates of Geologic Time. By WARREN UPHAM. Am. Jour. Sci., III, vol. xlv, pp. 209-220; March, 1893. Recent estimates of the age of the earth vary widely, but this paper shows that the more reliable geologic measurements and ratios lie inside the probable limit of 100 million years assigned from physical data by Sir William Thomson (now Lord Kelvin). Computations by Wallace, based on the rates of land erosion and consequent oceanic sedimentation, allow 28 million years for the deposition of all the sedimentary rock strata. Mr. Upham, however, shows that by certain reasonable changes in the premises of this computation the result would be three times as great or 84 million years. Another method of reaching an estimate is found in the ratios of the Recent and Glacial periods to the preceding and far longer geologic eras. The mean of numerous independent measurements of the probable length of the Postglacial or Recent period, from the departure of the ice-sheets to the present time, is 8,000 years; and for the duration of the Glacial period the writer accepts Prestwich's opinion, that the Ice age in reaching its culmination occupied 15,000 to 25,000 years and in waning continued onward perhaps 8,000 to 10,000 years or less. Further, from the rate of extinction and new appearance of marine molluscan species, the proportion of Glacial and Recent time to that since the beginning of the Tertiary era is believed to be as one to fifty or a hundred. Thence, according to closely agreeing ratios deduced from comparison of the thicknesses of the rock strata by Dana, Alexander Winchell, and Davis, the lengths of the successive eras since the Archæan are estimated to have been, for the Paleozoic, 36,000,000 years; the Mesozoic, 9,000,000; and the Cenozoic, comprising both Tertiary and Quaternary time, 3,000,000. In the Quaternary or present era Mr. Upham would include not only the Ice age and subsequent time but also a somewhat long time of preglacial increasing high uplift of the areas that became finally ice-enveloped, giving to the Quaternary in all probably 100,000 years, or about a thirtieth part of the entire Cenozoic.

The Glacial Succession in Ohio. By FRANK LEVERETT. Journal of Geology, vol. i, pp. 129-146, with map; Feb.-March, 1893. Ten approximately parallel and successively formed terminal moraines of the Mau-

mee-Miami lobe of the ice-sheet in western Ohio and eastern Indiana are shown on the map accompanying this paper. In the summary of his conclusions, drawn from a very thorough examination of the drift in Ohio and the country westward to the Mississippi river, Mr. Leverett enumerates the following stages of the Glacial period:

1. A glacial stage during which the ice-sheet extended farther south in western Ohio than in any later stage. During this glaciation the scarcity, if not absence, of coarse overwash material seems to indicate feeble drainage and low altitude.

2. A long stage of deglaciation marked by development of soil and by attendant oxidation, leaching, and erosion of the drift sheet. The character of the changes effected indicates fair drainage conditions, the altitude being probably not much lower than the present altitude of the region.

3. A stage of silt deposition during which the highest points in southwestern Ohio apparently became covered at flood stages. There can be little doubt that the region then stood several hundred feet lower than now. From evidence gathered elsewhere it seems probable that the silt deposition accompanied a glacial stage whose deposits are concealed in this region by later drift sheets.

4. .A glacial stage, during which the outermost well-defined frontal moraine was formed, with as good attendant drainage as is now afforded in the western Ohio region. The drift of this stage is concealed in eastern Ohio by the later moraines. The main streams at the time of this ice invasion flowed at levels 200 feet or more below the level of the upland silt.

5. A stage of deglaciation of considerable length, with altitude somewhat as at present, indicated by valley excavation.

6. A glacial stage characterized by sharply indented morainic ridges. The land at this time was probably raised to a maximum of elevation, there being ample evidence of vigorous drainage, not only in Ohio, but as far to the west as the moraine has been correlated. The ice-sheet reached about to the glacial boundary in eastern Ohio, but fell short many miles of reaching the boundary farther west.

7. A glacial stage characterized by morainic ridges of smooth contour. This stage embraces the final disappearance of the ice-sheet from Ohio. A deglaciation interval is believed to have preceded it, but decisive evidence in support of this view is not obtained. During the formation of these later moraines the land had again an altitude similar to that of to-day.

"Still later," writes Mr. Leverett, "the Champlain submergence of the coast and St. Lawrence occurred. It is important to note that the Champlain submergence is separated from the submergence which produced the silts of southern Ohio by the periods of high altitude just mentioned, a succession of periods during which all the Ohio moraines, no less than twelve in number, were being formed." This opinion, however, seems open to doubt. The depression when the silts and loess were being deposited and the marine submergence of the coast of Maine and New

Brunswick, the St. Lawrence valley, and the lake Champlain basin, may be parts of a single subsidence from which the southern area was uplifted earlier than the northern.

If the Ice age was primarily caused, as Jamieson, Upham, Wright, Hilgard and others maintain, by great epeirogenic uplifts of the glaciated portions of the continents some thousands of feet higher than now, then the gradual though fluctuating recession and departure of the ice-sheets were probably conversely due to the depression of the ice-loaded lands to their present hight or lower. When the depression had caused a considerable glacial retreat, the increase in thickness of the ice-sheets by series of centuries bringing exceptional snowfall may have raised their surface so high that now and again the ice was enabled to advance far over tracts which it had previously abandoned, leaving its conspicuous moraines as marks of these stages of fluctuation. After the borders of the drift-bearing area were unburdened by the glacial recession, they appear soon to have been moderately uplifted, attaining their present hight or oscillating somewhat above and below this hight. A chiefly permanent wave of elevation, slowly extending from south to north as the ice-sheet fluctuatingly departed, seems to have raised earliest the silt and loess area of the Ohio, Mississippi, and Missouri region, later and progressively the areas of the glacial lakes Agassiz, Warren, and Iroquois, with the Champlain and St. Lawrence valleys, and latest the region of Hudson bay, where, according to Dr. Robert Bell, this uplift is still in progress and now averages apparently several feet in a hundred years. The Postglacial or Recent period has been too short both in North America and Europe to bring yet the full restoration of isostasy by completion of the uplift of the glacially depressed portions of these continents, for as about Hudson bay so in Scandinavia the postglacial elevation still continues at a measurable rate.

The Moon's Face; a study of the origin of its features. By G. K. Gilbert. Address as retiring president, delivered Dec. 10, 1892. Bulletin, Phil. Soc. of Washington, vol. xii, pp. 241-292, with a plate and fourteen figures in the text. The geologist here becomes a selenologist. Whoever has looked with a telescope, even of the small power of the ordinary surveyor's level or transit, upon the illumined face of the moon and seen its so-called craters, especially when at the moon's quarter phases their serrated rims cast long shadows near the boundary of the lighted area, must have wondered at the apparent violence and grandeur of the volcanic action to which these scars of our satellite have been commonly ascribed. Mr. Gilbert, however, shows in this paper that the lunar craters differ so much in their range of magnitude, in the deep depression of their central plains below the outer expanse surrounding the crater rims, and in other respects, from terrestrial craters, whether of the Vesuvian or Hawaiian types, that they cannot reasonably be supposed to be of volcanic origin. He thinks, therefore, and sustains his view with very able arguments, that the moon has come to its present form from the breaking up of an original ring of satellite matter, like the rings of Saturn. Many agglomerations of this matter

were tardy in joining the chief resultant mass, and the latest of them, in falling by gravitation to the moon, melted by the impact not only themselves but the part of the lunar surface where they struck, and threw up around these places the crater rims as steep mountains. The whole process of the moon's gathering its formerly scattered material seems, according to Mr. Gilbert, to have been completed at least before the deposition of the earth's Paleozoic sediments, else they would here and there reveal evidences of collision of some of the portions of the previous ring matter, since these must have fallen not only on the moon but in like manner on the earth. The absence of atmosphere about the moon has so long permitted the very steep and high lunar mountains to remain unaffected by agencies of erosion.

Geographical Illustrations: suggestions for teaching Physical Geography based on the physical features of southern New England. By WILLIAM MORRIS DAVIS, Professor of Physical Geography in Harvard University. 12mo, pp. 46, Cambridge, Mass., 1893. Price, 10 cents. In this excellent little pamphlet the chief topographic features of Massachusetts, Rhode Island, and Connecticut are described, and their means of origination by subaërial erosion, partial or nearly complete base-levelling, succeeding uplifts and new valley cutting, and latest by glaciation, are explained. This is done so simply, clearly, and attractively, although giving the latest and in part very recent results of the most advanced investigators in geology and geomorphology, that the teachers of primary and grammar schools may readily take their classes over this partially new scientific ground, without their encountering any difficulties beyond their understanding, and even with dawning and increasing pleasure instead of becoming wearied.

Ytbildningar i ryska och finska Karelen med särskild hänsyn till de karelska randmoränerna. By J. E. ROSBERG, pp. 128, with a map, sections, and photographs. Fennia, vol. vii, No. 2, Helsingfors, 1892. The glacial geology of a broad belt of Finland and northwestern Russia, stretching from the Gulf of Finland and lake Ladoga north to the northwestern extremity of the White sea, forms the subject of this number of Fennia. The map shows the directions of glacial striation, sand and gravel tracts of modified drift, dunes, marginal retreatal moraines, and eskers.

RECENT PUBLICATIONS.

I.

Government and State Reports.

Geological Survey of Arkansas, John C. Branner, state geologist, 1891, Vol. I, Mineral Waters.

Pennsylvania Geological Survey, J. P. Lesley, state geologist, 1892, Vol. II, Summary Final Report, Upper Silurian and Devonian.

Report of the Mineral Products of the U.S., D.T.Day, U.S. Geological Survey, Department of the Interior. Report for 1892, Coal, E.W. Parker.

Annual report of Curator of the Museum of Comparative Zoology at Harvard College for 1891-92.

Geological Survey of Texas. Report on Brown Coal and Lignite of Texas, E. T. Dumble, state geologist, 1892.

Geological Survey of Missouri, biennial report of state geologist A. Winslow. Preliminary report on Coal Deposits of Missouri, 1891-92; Vol. II, report on Iron Ores, by F. L. Nason; Vol. III, report on Mineral Waters, by P. Schweitzer.

Michigan Mining School, catalogue for 1891-92.

Geological Survey of Indiana, 17th annual report of the state geologist for 1891, contains: Report on Building Stones found in Indiana, by Maurice Thompson; Geology of Steuben and Whitley counties, C. R. Dryer; partial catalogue of the Flora of Steuben county, E. Bradner; Geology and Natural History of Carroll county, M. Thompson; Geology of Wabash county, M. N. Elrod and A. C. Benedict; partial list of Flora of Wabash and Cass counties, A. C. Benedict and M. N. Elrod; report of the inspector of mines, T. McQuade; report of state supervisor of Oil Inspection, N. J. Hyde; Petroleum in Indiana, A. C. Benedict; report of supervisor of Natural Gas, E. T. J. Jordan; catalogue of Butterflies known to occur in Indiana, W. S. Blatchley; Batrachians and Reptiles of the state of Indiana, O. P. Hay; Paleontology, S. A. Miller.

II.

Proceedings of Scientific Societies.

Trans. Wagner Free Institute, Vol. III, Pt. II, contains: Contributions to the Tertiary Fauna of Florida with special reference to the Miocene Silex-beds of Tampa and the Pliocene beds of the Caloosahatchie River, W. H. Dall.

New Orleans Academy of Science, Proc., contains: Topography of New Orleans, B. M. Harrod; Archæan Rocks in Texas, B. M. Harrod.

Jour. of the Cin. Soc. Nat. History contains: Observations concerning Fort Ancient, S. S. Scoville; Microscopical Study of Ohio Limestones, G. P. Grimsley; Manual of the Paleontology of the Cincinnati Group, J. F. James; Niagara's Water Power, B. M. Ricketts.

Proc. Acad. Nat. Sci. of Phila. contains: A Revision of North American Creodonta, W. B. Scott; Geology of the Isles of Shoals, T. D. Rand: A Hyæna and other Carnivora from Texas, and The Permanent and Temporary Dentition of Certain Three-Toed Horses, by E. D. Cope; Notes on the Geology of Mt. Desert Island, H. C. Chapman; A Meteoric Stone seen to fall at Bath, S. D., A. E. Foote; Extra-Morainic Drift in the Susquehanna, Lehigh and Delaware Valleys, by G. F. Wright.

III.

Papers in Scientific Journals.

Geol. Magazine, *December*, contains: The Wenlock and Ludlow Strata of the Lake District, J. E. Marr; On the Occurrence of the Chon-

etes Pratti in Western Australia, R. B. Newton; Notes on Schist-making in the Malvern Hills, C. Callaway; On Yorkshire Thecidea, J. F. Walker; Notes on Russian Geology, W. F. Hume; Granite, T. R. Struthers.

Amer. Jour. Sci., *December*, contains: Remarkable Fauna at the base of the Burlington Limestone in Northeastern Missouri, C. R. Keyes; Glacial Pot-holes in California, H. W. Turner; Lavas of Mt. Ingalls, California, H. W. Turner; Notes on the Cambrian Rocks of Pa. and Md. from the Susquehanna to the Potomac, C. D. Walcott; Volcanic Rocks of South Mountain in Pa., G. H. Williams. *January*, contains: The Age of the Earth, by Clarence King; Tertiary Geology of Calvert Cliffs, Md., by Gilbert D. Harris; Anglesite Associated with Boleite, by F. A. Genth; Preliminary Notice of a Meteoric Stone seen to fall at Bath, S. D., by A. E. Foote; Appendix, New Cretaceous Bird, allied to Hesperornis, by O. C. Marsh; Skull and Brain of Claosaurus, by O. C. Marsh. *February*, contains: Datolite from Longboro, Ont., by L. V. Pirsson; Stannite and some of its Alteration Products from the Black Hills, S. D., by W. P. Headden; Occurrence of Hematite and Martite Iron Ores in Mexico, by R. T. Hill, with notes on the associated Igneous Rocks, by W. Cross; Ceratops Beds of Converse county, Wyoming, by J. B. Hatcher; Lines of Structure in the Winnebago county Meteorites and in other Meteorites, by H. A. Newton; Preliminary Note of a New Meteorite from Japan, by H. C. Ward.

School of Mines Quar., *November*, contains: Classification of Ore Deposits, J. F. Kemp; Rapid Qualitative Examination of Mineral Substances, A. J. Moses and S. C. Wells; Note on the Geology of Monte Cristo Dist., Washington, C. W. Feuner; Mineralogical Notes, A. J. Moses, E. Walker, B. C. Hinman and W. D. Matthew.

Amer. Naturalist, *January*, '93, contains: Certain Shell Heaps of the St. John's River, Florida, hitherto unexplored, by Clarence B. Moore. *February*, 1893, contains: Summary of the Progress of Mineralogy and Petrography in 1892, W. S. Bayley. *March*, 1893, contains: Titanotherium Beds, J. B. Hatcher.

Bulletin of the Amer. Geog. Soc., Vol. XXIV, No. 4, Pt. I, 1892, contains: The North Greenland Expedition of 1891-92.

National Geographic Magazine for *February* 8, 1893, contains: North American Deserts, by Prof. Dr. J. Walther.

School of Mines Quarterly, *January*, 1893, contains: Memorial of Prof. John Strong Newberry, by J. F. Kemp; Notes on the Huauchaca Mine, Bolivia, S. A., by Robert Peele, Jr.; Note on the El Callao Gold Mine of Venezuela, by Robert Peele, Jr.

Appalachia for *February*, 1893, contains: An Ascent of Mt. Ritter (with illustrations), Joseph LeConte, Jr.; Drumlins near Boston, by Warren Upham; A Map of New England and Eastern New York, locating prominent summits.

The National Geographic Magazine for *February*, 1893, contains: Proceedings and Publications of the National Geographic Society.

Scientific Quarterly for *March*, 1893, contains: The Geological training of a Prospector, by A. Lakes; The Minerals of Colorado, by J. S. Randall.

IV.

Excerpts and Individual Publications.

Notes on a trip to the Lapari Islands, Wm. H. Hobbs, Trans. of the Wis. Acad., Vol. IX.

Organic Matter as a Geological Agent, A. Irving, Proc. Geol. Assoc., Vol. XII.

On the Geology of part of the Province of Quebec, south of the St. Lawrence River, R. W. Ells, Trans. Roy. Soc. Canada, Sec. IV, 1891.

The Pleistocene History of Northeastern Iowa, W J McGee, 11th annual report, U. S. Geol. Survey, 1889-90.

The Eruptive Rocks of Electric Peak and Sepulchre Mountain, Yellowstone National Park, Joseph Paxson Iddings, 12th annual report, U. S. Geol. Survey, 1890-91.

The North American Continent during Cambrian Time, Charles D. Walcott, 12th annual report, U. S. Geol. Survey, 1890-91.

Note on the occurrence of Grahamite in Texas, E. T. Dumble, Trans. Amer. Instit. Mining Engineers, Oct., 1892.

On the Contrast and Color of the Soils of High and Low Latitudes, W. O. Crosby, Proc. Bos. Soc. Nat. Hist., Vol. XXIII, pp. 219-222.

Geology of Hingham, Mass., W. O. Crosby, Proc. Bos. Soc. Nat. Hist., Vol. XXV, May 18, 1892.

Source of the Texas Drift, E. T. Dumble, Proc. Tex. Acad. Sci.

Volcanic Dust in Texas, E. T. Dumble, read June 14, 1892, Trans. Tex. Acad. Sci.

Notes on the Geology of Skunnemunk Mountain, Orange county, N. Y., Chas. S. Prosser, Topeka, Kansas, Trans. N. Y. Acad. Sci., Vol. XI, Nos. 6, 7, 8, June, 1892.

Notes on the Geology of the Valley of the Middle Rio Grande, E. T. Dumble, Bul. Geol. Soc. Amer., Vol. III, pp. 219-230.

1. Petrographical Notes, N. Y. Acad. Sci., Vol. XI, Nos. 6, 7, 8. 2. The Great Shear Zone at Avalanche Lake in the Adirondacks, J. F. Kemp, Amer. Jour. Sci., Aug., 1892.

The Manufacture of Coke, Jas. D. Weeks, Extr. Min. Resources of U. S , 1891.

Twenty Years of Progress in the Manufacture of Iron and Steel in the U. S., James M. Swank, Extr. Min. Resources of U. S., 1891.

Finite Homogeneous Strain, flow and rupture of rocks, by Geo. F. Becker, Bul. Geol. Soc. Amer., Vol. IV, pp. 13-90, 1893.

Determination of the dates of the publication of Conrad's "Fossils of the Tertiary Formation" and "Medial Tertiary," by Wm. H. Dall, Philosophical Soc. of Washington, Bul., Vol. XII, pp. 215-240, 1893.

Natural Gas Fields of Indiana, by Arthur John Phinney, 11th annual report of director of U. S. Geol. Survey, 1889-90.

Note on the Quartz-bearing Gabbro in Maryland, by U. S. Grant, Johns Hopkins University Circulars, No. 103, February, 1893.

Shippen and Wetherill Tract, by Benj. Smith Lyman.

The Production of Columbous and Tungstous Oxides in forming Compounds of Iron and Tin, by Wm. P. Headden, Proc. Colo. Sci. Soc., 1893.

Review of R. T. Hill's report on the Artesian Water in Texas, by W. F. Cummins.

Terminal Moraines in New England, by Prof. C. H. Hitchcock, Proc. Amer. Assoc. for the Adv. of Science, Vol. XLI, 1892.

Notes on the Clays of New York State and their economic value, Heinrich Ries, Trans. N. Y. Acad. Sci., Vol. XII, Dec., 1892.

On the Separation of Minerals of High Specific Gravity, E. W. Dafert and O. A. Derby, Proc. Rochester Acad. Sci., Vol. II.

Continental Problems, G. K. Gilbert, Bul. Geol. Soc. of America, Vol. IV, pp. 179-190.

Phases in the Metamorphism of the Schists of Southern Berkshire, W. H. Hobbs, Bul. Geol. Soc. of America, Vol. IV, pp. 167-178, Pl. 3.

Manual of the Paleontology of the Cincinnati Group, by Jos. F. James, Pt. IV, Jour. Cin. Soc. Nat. Hist., 1892-93.

The Conditions of Erosion beneath deep Glaciers, based upon a study of the Boulder Train from Iron Hill, Cumberland, R. I., Bul. Mus. Comp. Zool. Harvard College, Vol. XVI, No. 11.

Scientific Publications of O. C. Marsh, Reprint from Bibliographies of the officers of Yale Univ.

Archæopneustes abruptus, a new genus and species of Echinoid from the Oceanic Series in Barbados, J. W. Gregory, Jour. Geol. Soc., May, 1892, Vol. XLVIII.

Trematobolus, an Articulate Brachiopod of the Inarticulate Order, by G. F. Matthew, Can. Record of Science, Jan., 1893.

V.

Foreign Publications.

Die geognostischen Verhältnisse am nordwestlichen Harzrande zwischen seesen und Hahausen unter specieller Berücksichtigung der zechsteinformation, von Herr J. H. Kloos in Braunschweig, aus dem Jahrb. der königl. preuss. geologischen Landesanstalt für 1891.

Geological Survey of New South Wales, Vol. III, Part I, 1892, contains: Description of the Belubula Caves, Parish of Malongulli, Co. Bathurst, C. S. Wilkinson; Hymenocaris salteri, R. Etheridge: Notes on Geology and Mining in the Turnkey and Tuena Districts, G.A.Stonier; Notes on the Intrusive Serpentine at Gundagai, P. T. Hammond; Notes made at the Kybean Caves, Parish of Throsby, Co. Beresford, 1890, R. Etheridge: Notes on the teeth known as Sceparnodon ramsayi, W. S. Dun; Notes on the occurrence of Opal in New South Wales, Wm. Anderson; Note on the intrusive Porphyry at Melrose, P. T. Hammond; Idiographic Drawings by the Aborigines in a cave-shelter at Weeney Creek, Colorado River, near Richmond, R. Etheridge; The Caves at Goodravale, Goodradigbee River, R. Etheridge.

Geology and Mineral Resources of the Upper Burdekin, Queensland, A. Gibb, Maitland, contains: Proposed Boring for Water at Brisbane, Robt. L. Jack, Queensland; Paradise Gold Field, Queensland, Wm. H. Rands; Broken Hill, Queensland, Robt. L. Jack; Coolgara Tin Mines and Surrounding District, Queensland, A. Gibb, Maitland; The Mines near

Cooktown, Queensland, Robt. L. Jack; Cape River Gold Field, Queensland. Wm. H. Rands; Geology of Cooktown Dist., Queensland, A. Gibb, Maitland; Styx River Coal Field, Queensland, Wm. H. Rands; New Discovery of Coal near the Callide Creek, Port Curtis Dist., Queensland, Wm. H. Rands; Mt. Morgan Gold Deposits, Queensland, Robt. L. Jack; The Physical Geography of Magnetic Island, Queensland, A. Gibb, Maitland.

Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales, No. 5, Pt. II, R. Etheridge, Jr., Dept. of Mines, Geol. Survey, N. S. Wales.

Berichte der Naturfurschenden Gesellschaft zu Freiburg, I b. Jahr, September, 1892, contains: W. Mæricke, Vergleichende Studien über Eruptivgesteine und erzführung in Chile und Ungarn; G. Boehm, Ein Beitrag zur Kenntniss der Kreide in den Venetianer Alpen; G. Steinmann, Bemerkungen über die Tektonischen Bezeihungender oberrheinschen Tiefebene zu dem Nordschweizerischen Kettergura.

Ueber das Alter des Tarflagers von Lauenburg, a. d. Elbe, von H. Credner, E. Geinitz und F. Wahnschaffe, Oct., 1892. Separat-abdruck aus dem Neuen Jahrbuch für Mineralogie, etc., 1893, Bd. I.

Berichte der Naturfarsdrenden Gesellschaft zu Freiburg, I. h. sechster Band, zweites Heft, contains: G. Boehm, Megalodon, Pachyerisma, und Diceras.

Eclogæ Geologicæ Helvetiæ, Vol. III, No. 3, contains: Muhlberg, Jura zwischen Aarau und Oten (mit Tab. VIII); Schardt, Effondrement du quai de Montreux; Rollier, Rauracien du Jura.

Zeitschrift für praktische Geologie, Vol. I, No. 1, Jan., '93, contains: Fr. Beyschlag, Geologische Specialaufnahem; J. H. L. Vogt, Bildung von Erzlagerstätten durch Differentiationsprocesse in basischen Eruptivmagmata (Fig. 1 bis 6); F. Wahnschaffe, Geologie und Ackerbau; A. Baltzer, Bericht über einleitende Arbeiten am unteren Grindelwaldgletscher zur empirischen Bestimmung der Eiserosion; Th. Breidenbach, Das Goldvorkommen in nörlichen Spanien; P. Groth, Ueber neure Untersuchungen ast alpiner Erzlagerstätten; R. Beck, Das Steinkohlenbecken des Planenschen grundes bei Dresden; R. Helmhacker, Die Mineralkohlen in Russisch-Asien; C. Ochsenius, Ueber unterirdische Wasserausammlungen; Goldproduction der Welt; Gold-und Silbererzeugung im Jahre, 1891; Zur Geologie des Quecksilbers; Artesische Brunner; Kleinere Mittheilungen.

The terms of Auxology, by S. S. Buckman and F. A. Bather, from the Zoologischen Anzeiger, No. 405 u. 406, 1892.

Beitrage zur Stratigraphie und Tektonik der Mittelböhmischen Silurformation, von Dr. J. J. Jahn, Jahrbuch der k. k. geolog. Reichsanstalt, 1892, Bd. 42, Heft 3.

Mineralogischen und Petrographischen Mittheilungen, F. Becke, 11, Zur genauen Kenntniss der Phonolithe des Hegaus, by H. P. Cushing and E. Weinschenk in München.

Compte-Rendu des Séances de la Société Géologique de France, 1893, Ser. 3, Tome XXI.

Records of the Geol. Survey of New South Wales contains: On the Geological Occurrence of the Broken Hill Ore Deposits, E. F. Pittman; The Pentameridæ of New South Wales, R. Etheridge, Jr.; Geological Notes on the Swamp Oak and Niangala Gold Fields, G. A. Stonier; Report on a Visit to the Narrangullen, a Cavan Cave, Tæmas, Murrumbidgee River, R. Etheridge, Jr.

Bulletin de la Société Géologique de France, Ser. 3, T. XX, No. 4, 1892, contains: Contribution a l'étude du terrain tertiaire d' Alsace (Suite), Kleinkembs et lac sundgonien, M. Mieg, G. Bleicher et Fliche; Sur les terrains phosphates des environs de Doullens, étage Senonien et terrains superposes, 2e note, H. Lasue; Sur le gisement et la structure des nodules phosphate du Lias de Lorraine, Bleicher; Contributions à l'étude géologique du Rouergue et de la Montagne Noire, J. Bergeron; Observations sommaires sur le Boulonnais et la Jura, Bourgent (l'abbé); Note sur les Poissons du terrain Permien de l' Allier, H. E. Sauvage.

Furher durch die Geologischen Sammlungen des Provinzialmuseums der Physikalisch-Oekonomischen Gesell. zu Königsberg bearbeitet vom Direktor Prof. Dr. A. Jentzsch, Uebersicht der Geologie Ost-und Westpreussens, mit 75 Text. und zwei Tabellen.

The Eocene and Oligocene Beds of the Paris Basin, by G. F. Harris and H. W. Burrows, read before the Geologists' Association, 1891.

Geology of the Gironde, G. F. Harris, Geological Magazine, Jan., 1890.

London Water Supply, G. F. Harris, National Laundry Record, Jan. 27 and Feb. 24, 1892.

The Correlation Table of British with continental Tertiary Strata, G. F. Harris, Ex. from a list in the Brit. Mus. by R. B. Newton.

CORRESPONDENCE.

Note on a Fall of Volcanic Dust in the South Atlantic Ocean. A sample of volcanic dust has recently been presented to Director Edw. S. Holden, of the Lick Observatory, by Capt. W. W. Hardy, of the bark W. W. Crapo, with the following notes on its occurrence: "The shower of dust occurred between 8 and 9 p. m., May 26th, 1892, in lat. 43° S., long. 54° 20′ W.; the wind N. W., velocity about 8 miles per hour. At sunset, four hours before the shower, the western sky was very red." The sample was transmitted by Director Holden to the Mineralogical Museum of the University of California.

The geographic position mentioned is distant 370 miles in a southeast direction from the nearest land—the coast of the Argentine Republic, and about 600 miles north of the Falkland Islands. The nearest volcanoes are those of the Southern Andes, distant about 500 miles to the northwest.

The dust is a fine powder, slightly gritty and of a dirty white color.

On agitating a portion in water it was found that a considerable part was exceedingly fine and remained in suspension, while the remainder subsided as a granular powder of nearly uniform grain. The specific gravity of the latter as determined by the specific gravity bottle was 2.433.

Under the microscope the dust is seen to be composed chiefly of fragments of glass and crystals and crystal fragments of hornblende and feldspar.

The glass is much the most abundant material. The fragments, which are all sharply angular, vary in size from less than .01 mm. up to .28 mm. in diameter, the average diameter being about .05 mm.

The glass is for the most part compact, clear and colorless, but occasional pumiceous fragments were observed and others stained brown or yellow by iron oxide.

The feldspar is next in order of abundance and occurs in prismatic crystals and in angular crystal fragments. The largest crystals observed measured .14 mm. to .308 mm. in length and .084 mm. to .126 mm. in breadth. Some of the fragments were recognized as plagioclase by distinct polysynthetic twinning, but the majority appeared to be simple crystals and are perhaps orthoclase. Tiny inclusions of magnetite were observed in some of the feldspar crystals.

The hornblende is slightly less abundant than the feldspar, but the crystals are of larger average size. The largest crystal observed measured .3 mm. in length and .1 mm. in breadth; the average was about half that size. The hornblende is readily recognized by its prismatic habit and cleavage, green color, strong pleochroism, and small extinction angle.

In the powder that was washed with water several shining cleavage fragments were observed. Under the microscope, one of these gave rather uncertain reactions for pyroxene. It is present in very small quantity.

Rather numerous particles of magnetite are present, the largest of which measured about .056 mm. in diameter. Many of these grains had fragments of glass or feldspar attached to them.

The mineralogical composition and specific gravity of this volcanic dust would point to its derivation from a somewhat acid andesitic magma. CHARLES PALACHE.

Geological Laboratory, University of California, March 20th, 1893.

BELTRAMI ISLAND OF LAKE AGASSIZ. After returning last month for a season of work on the Minnesota Geological Survey, one of my earliest duties was to examine the profiles of the three railroad lines, with their branches, which have recently been built (and are now being extended) from Duluth northward across the rich iron and lumber district of northern Minnesota. One of these, the Duluth & Winnipeg railroad, passing northwest by the east end of Red lake and the southwest side of the Lake of the Woods, shows that the former of these lakes lies about 40 feet and the latter somewhat more than 150 feet below the

highest level of the glacial lake Agassiz, which during the departure of the ice-sheet was pent up in the basin of the Red river of the North and of lake Winnipeg by the receding ice-barrier.* The hight of Red lake above the sea is ascertained to be 1172 feet; and of the Lake of the Woods, in its stages of low and high water, 1057 to 1063 feet. Northeast of Red lake the Tamarack river drains a large tract of tamarack, spruce, and arbor vitæ swamp, which reaches to the divide between the Tamarack river and the West branch of the Bowstring river (more commonly called the Big Fork), tributary to Rainy river, the hight of the divide being only 15 to 20 feet above Red lake. Similar low swamp land forms nearly the whole northern and northwestern shore of Red lake and is crossed by this railroad survey continuously along its first eighteen miles beyond Red lake; but at a distance of twenty-nine miles from the lake the profile shows an ascent crossing the highest beach of lake Agassiz, which there is 1215 feet above the sea. The next seventeen miles of the profile extend across the northeastern edge of a large island of lake Agassiz, rising on that line to a maximum hight of 1283 feet, with a moderately undulating drift-covered surface. In the next fifteen miles, which comprise the descent on a similar but smoother drift surface from the highest shore of lake Agassiz to the War Road river, an affluent of the Lake of the Woods, the profile crosses a succession of ten lower beaches of lake Agassiz, marking stages in the gradual uplifting of the land and subsidence of the lake, their altitudes above the sea being 1196, 1172, 1156, 1143, 1127, 1116, 1106, 1099, 1093, and 1087 feet.

These data show that lake Agassiz in its highest stage had a large island northwest of Red lake, comprising the headwaters of numerous streams flowing outward from it to the Lake of the Woods, Rainy river, Red lake, the Red Lake river, and the Red river of the North. This island had probably a diameter of forty miles or more, with an area exceeding 1000 square miles, of which apparently more than half is in Beltrami county, the portion farther west being chiefly in Marshall county, Minn. For this tract, which has before been supposed to be comparatively low and perhaps wholly beneath the highest level of lake Agassiz, the name *Beltrami Island* is proposed, in recognition of the exploration of the region of Red lake and the Julian or most northern sources of the Mississippi by Beltrami in 1823 (Geol. of Minn., vol. i, 1884, pp. 44-50, with map). As Prof. N. H. Winchell wrote in the historical sketch here cited, this district "is still nearly as wild and uninhabited as when Mr. Beltrami passed through it." During the field work of this survey the present season, the boundaries and contour of this island will be mapped.

Beltrami island lies in the course of northwestward and northward continuation of the Mesabi or eleventh moraine of the series mapped in

*Geol. and Nat. Hist. Survey of Minn., Eighth annual report, for 1879, pp. 84-90; Eleventh annual report, for 1882, pp. 137-153, with map; Final report, vol. ii, 1888, pp. 517-527. U. S. Geol. Survey, Bulletin No. 39, with map, 1887. Geol. and Nat. Hist. Survey of Canada, Annual report, new series, vol. iv, for 1888-89, part E, with maps and sections. Am. Geologist, vol. vii, pp. 188-194, 222-231, March and April, 1891.

Minnesota, which next east from the Narrows of Red lake rises very prominently to a hight of 150 to 200 feet for a distance of about ten miles upon the peninsula dividing the northern and southern parts of the lake. Like nearly the entire western half or two-thirds of Minnesota, this whole region is deeply drift-covered. No outcrops of the bed-rocks have been yet found on the large portion of the Red river basin lying in Minnesota; but the conspicuous escarpment of Cretaceous shales, overspread by drift, along the west border of the Red river valley, wells penetrating to Cretaceous beds along this great valley plain, and the topographic features of the land rising eastward from it with nearly the same rate of ascent as on the west, lead to the belief that the eastern like the western border of this wide valley is formed by an escarpment of Cretaceous shales beneath the drift, and that an outlier of these shales enveloped by drift forms Beltrami island. It was long ago pointed out by Prof. N. H. Winchell that originally the Cretaceous strata extended over all the western two-thirds of Minnesota, and on the southeast almost to the Mississippi river, since they still are known to be largely continuous under the drift; and recent discoveries by Mr. H. V. Winchell of Cretaceous beds at several places along the elevated Mesabi iron range in northeastern Minnesota indicate indeed that the Cretaceous marine submergence probably reached to the present site of lake Superior.

WARREN UPHAM.

May 12th, 1893.

MESOZOIC GRANITE IN PLUMAS COUNTY, CALIFORNIA, AND THE CALAVERAS FORMATION. In a review of Mr. Mills' paper on the "Rocks of the Sierra Nevada,"* the writer makes the statement "that there is thus no evidence extant that the granite of Plumas county is intruded into rocks later in age than the Carboniferous."

In making the statement I had overlooked a paragraph in Mr. Diller's paper on the "Geology of the Taylorville Region," p. 394, where occurs the following:

"The dioritic rocks of the region are a portion of the great granitoid mass of the upper Sierra Nevada, and are evidently eruptive, with well defined contact phenomena in Triassic formations. Their eruption is certainly post-Triassic, and may have taken place immediately at its close, or after the deposition of the Jurassic."

The "Calaveras formation" on p. 309 of the same number of the GEOLOGIST is defined as including "all of the Paleozoic sedimentary rocks of the Sierra Nevada." This definition may be correct as to the rocks of the Gold Belt proper on the western slope of the range where all the evidence gathered points to the Paleozoic rocks being Carboniferous in age, but it was not intended to include in the "Calaveras formation" the Grizzly Mountain Silurian beds described by Mr. Diller, nor the upper Carboniferous strata of Genesee valley, called by Mr. Diller the Robinson beds. These do not ar to enter into the composition of the main mass of the rang

*AM. GEOLOGIST, vol. XI

The "Calaveras formation" as thus limited comprises, so far as yet known, chiefly lower Carboniferous strata, but may extend down into the Devonian. The following fossils have been found within its limits:

Aviculopecten,	Clisiophyllum,	Spirifera,
Murchisonia,	Fusulina,	Phillipsastrea,
Macrocheilus,	Pleurotomaria,	Lithostrotion,
Zaphrentis,	Metoptoma,	Monticulipora.

The time range of the formation is thus not fully determined.

Washington, D. C. H. W. TURNER.

PERSONAL AND SCIENTIFIC NEWS.

MR. J. T. SCOVELL, WRITING IN *Science*, CLAIMS FOR CITLALTEPETL or Star mountain, more commonly called Mt. Orizaba, the distinction of being probably the highest point of North America. Spirit-levelling to the hight of 14,000 feet, and triangulation for the remaining hight, give the altitude of the summit as 18,314 feet, being 200 feet above that of Mt. St. Elias as determined by Russell, and 700 feet above Popocatepetl, which, until recently, was believed to be the highest of the Mexican volcanic cones. The crater of Citlaltepetl is about 800 feet long and 600 wide, with a depth between 400 and 500 feet. The upper 10,000 feet of the mountain consist of volcanic rocks, below which the lower slope, according to Mr. Hugo Finck, shows Cretaceous limestone, nearly horizontal, 200 or 300 feet thick, resting on crumpled and folded strata of Jurassic limestone, which in turn lie on alternating basaltic rocks and Carboniferous limestones. Cretaceous beds are crossed below the altitude of 2,500 feet in the descent to the Gulf of Mexico.

THE LAKES OF ZURICH AND WALLEN, respectively 460 and 560 feet deep, are shown by Du Riche Preller, in the *Geological Magazine*, to be due, not to glacial erosion, but to organic deformation of the Limmat valley.

THE FAUNAS AND FLORAS OF THE CHATHAM ISLANDS, New Zealand, and the southern portions of Australia, Africa, and South America, include so many identical or closely related species, in some instances, however, extinct and known only by fossil remains, that Mr. Henry O. Forbes argues therefrom, in a paper before the Royal Geographical Society, that in late geological times they received land migrations from an Antarctic continent which was more extensive and less frigid than now.

THE STATE OF SOUTH DAKOTA has established a geological survey, making it a function of the State University at Vermillion, on the plan of the Minnesota survey, and Prof. J. E. Todd has been appointed state geologist.

THE FAMILY OF THE LATE PROF. JOHN STRONG NEWBERRY, formerly professor of Geology in the School of Mines, have offered as a gift to Columbia College his large scientific library. The collection will be known as the Newberry Library of Geology, being a memorial to professor Newberry.

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